

3M Environment, Health and
Safety

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March 29, 2019



Express Mail

Mr. Joshua Rilying, Project Manager
Bureau of Land, Division of Remediation Management
Illinois Environmental Protection Agency
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Subject: 3M Cordova, IL Facility
1610150001 – Rock Island County
22614 IL 84 North

Dear Mr. Rilying:

On August 11, 2014, the Illinois Environmental Protection Agency (Illinois EPA) approved 3M's proposal to establish a Groundwater Management Zone (GMZ) at its Cordova, Illinois facility. As part of this commitment, 3M indicated that an annual report would be prepared to summarize the agreed upon environmental data collected in each calendar year. Accordingly, please find enclosed, two copies of a report entitled *2018 Annual Per- and Polyfluoroalkyl Substances (PFAS) Monitoring Report for the 3M Cordova, IL Facility, March 2019*.

As previously communicated, we would welcome the opportunity to meet and review the results generated in 2018, as there's need and/or interest in doing so. I will contact you in the next couple of weeks to see if there are any questions about the subject report and to discuss the merits of getting together to review the most recently generated data.

If you have any questions concerning this matter, please contact me at (651) 736-3135 or jmartin2@mmm.com.

Sincerely,

Jeannie Martin
Senior Environmental Scientist
Building 224-5W-17

Enclosures

c: J. Kotsmith – 224-5W-17
M. Parent/R. Stutzki – Cordova - US-ILCD01

bc: J. Sepesi – 220-9E-02
E. Hunter – 220-9E-02



**2018 ANNUAL PER- AND POLYFLUOROALKYL
SUBSTANCES (PFAS)
MONITORING REPORT FOR THE
3M CORDOVA, IL FACILITY**

March 2019

Prepared for:

3M Company

Prepared by:

**WESTON SOLUTIONS, INC.
West Chester, Pennsylvania 19380**

W.O. No. 02181.036.022.0002



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- April 2018 PFC Groundwater Analytical Data
- October 2018 PFC Groundwater Analytical Data



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1. INTRODUCTION

This 2018 annual monitoring report has been prepared by Weston Solutions, Inc. (WESTON®) for 3M Company (3M), and includes an assessment of per- and polyfluoroalkyl substances (PFAS) found in groundwater and the plant's wastewater discharge at the 3M Cordova, Illinois facility (Site). Since 2006, 3M has been working with the Illinois Environmental Protection Agency (Illinois EPA) Site Remediation Program (SRP) to evaluate the potential presence of PFAS in environmental media associated with former manufacturing operations at the Site.

This annual report provides the PFAS analytical results from groundwater sampling activities and groundwater elevation measurements completed in 2018. The groundwater monitoring program was implemented as described in the Groundwater Sampling Plan that was included in the *Proposal to Establish a Groundwater Management Zone (GMZ)* Report that was prepared by 3M and submitted to Illinois EPA in July 2014 (3M, 2014c). As requested by the Illinois EPA, this annual report also contains information on PFAS monitoring data for the plant's wastewater treatment plant (WWTP) discharge.

1.1 BACKGROUND

In August 2006, WESTON collected groundwater samples for PFAS analyses from the Site production wells in existence at that time. These samples were analyzed for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) and the results indicated that concentrations ranged between 0.2 and 12 nanograms per milliliter (ng/mL), or parts per billion (ppb), in the individual production well samples. Upon receipt of this analytical data, 3M notified Mr. Russ Irwin of the Illinois EPA, with the results by telephone on September 19, 2006, and in a subsequent e-mail on September 25, 2006. The analytical results were also presented by 3M to the United States Environmental Protection Agency (USEPA) Office of Pollution Prevention and Toxics (OPPT) during a meeting on October 13, 2006.

Numerous follow-up PFAS assessment activities were performed from 2008 through 2013 to characterize Site conditions and the presence of PFAS. These activities were conducted



in accordance with Illinois EPA-approved Work Plans and the results reported in numerous documents submitted to Illinois EPA. Activities included groundwater, soils and surface water investigations and assessments. Details of this past work, meetings and documents were presented in the *Environmental Assessment for Perfluorochemicals (PFCs) Summary Report, 3M Cordova, Illinois Facility* (3M, 2014a) that was submitted by 3M to the Illinois EPA in 2014. This document summarized the extensive environmental investigations performed at the Site and proposed a Groundwater Management Zone (GMZ) as an effective and appropriate remedial action for the Site.

In a letter from Illinois EPA to 3M dated June 13, 2014, Illinois EPA approved the *Request to Establish a Groundwater Management Zone (GMZ) Report* (3M, 2014b) received by Illinois EPA on April 25, 2014. This request was approved with the following conditions:

1. Per 35 Illinois Administrative code (IAC), Part 740, Section 740.530, map(s) and /or diagram(s) which show the three-dimensional area of the Groundwater Management Zone (GMZ) must be submitted to the Illinois EPA.
2. A Groundwater Sampling Plan must be submitted that will provide semiannual groundwater sampling data for the entire Groundwater Management Zone (GMZ).

3M addressed these conditions in the *Proposal to Establish a Groundwater Management Zone (GMZ)* report that was submitted to Illinois EPA in July 2014 (3M, 2014c). This proposal contained information that delineated the three-dimensional area of the GMZ and included the GMZ Groundwater Sampling Plan to provide semiannual groundwater sampling data. In correspondence dated August 11, 2014, the Illinois EPA approved 3M's request to establish a GMZ based on information submitted to the agency.

The results of the 2018 water sampling activities, performed in accordance with the GMZ Groundwater Sampling Plan, are provided in this document. Groundwater sampling and depth-to-groundwater measurements were performed at the Site in April and October 2018. The sampling events in 2018 represent the eighth and ninth rounds of sampling performed in accordance with the GMZ Groundwater Sampling Plan.



2. SITE LOCATION AND DESCRIPTION

The 3M Cordova facility, located at 22614 Route 84N, Cordova, Illinois, is approximately one mile north of Cordova, Illinois, in northwestern Rock Island County, along the eastern bank of the Mississippi River as shown on Figure 2-1. The manufacturing portion of the site is bordered by the Burlington Northern Santa Fe (BNSF) Railroad and Route 84 to the east, the Mississippi River to the west, and other commercial/industrial properties to the north and south.

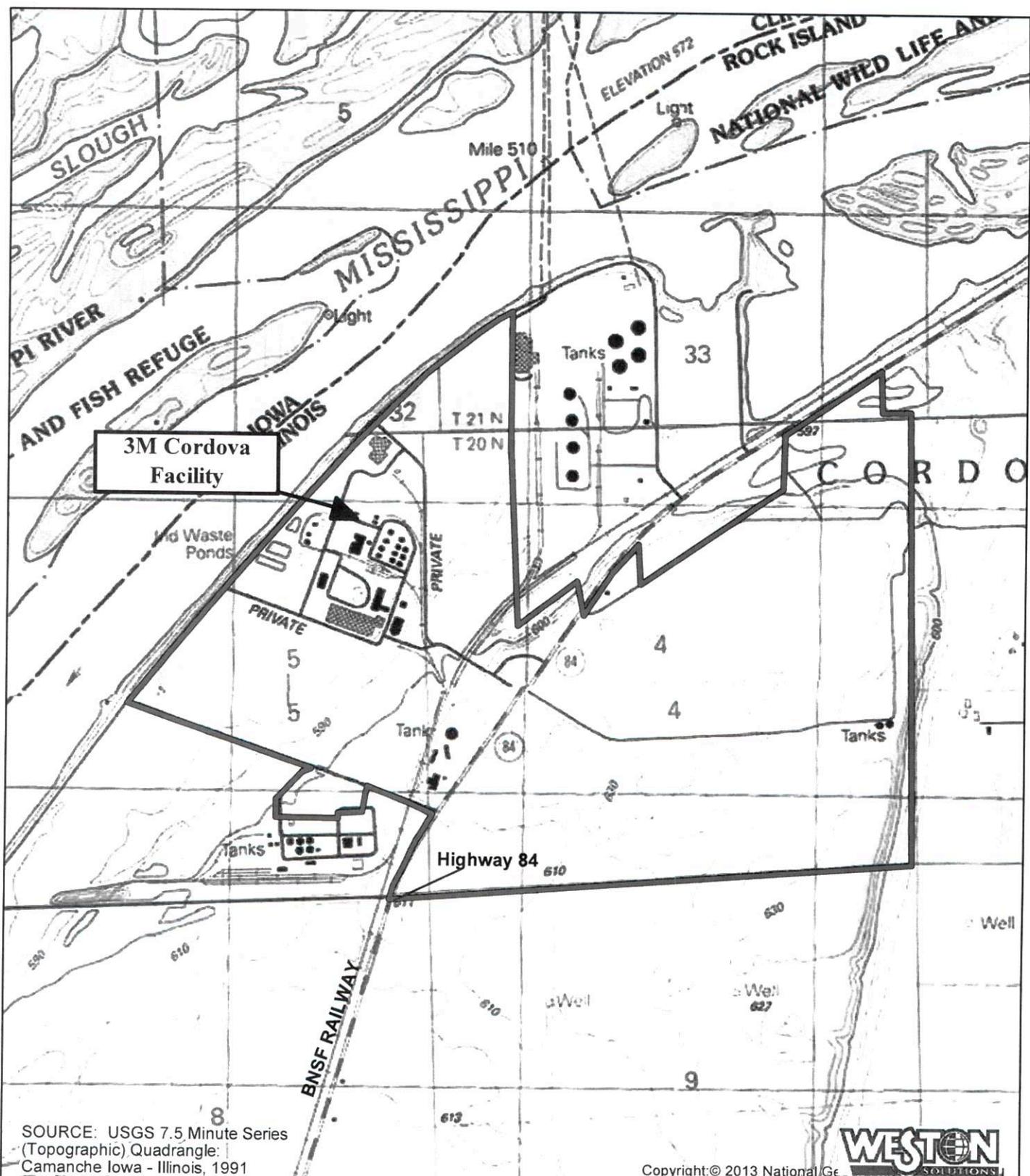
The 3M Cordova manufacturing facility, originally constructed in 1970, consists of numerous structures on a 739-acre plot. Manufacturing is conducted on an approximate 100-acre triangular portion of the Site, west of Highway 84 and adjacent to the river. Figure 2-2 depicts the current site layout of the manufacturing portion of the facility. An on-site wastewater treatment plant (WWTP) is located along the western edge of this manufacturing area and is used to treat all process and sanitary wastewater generated at the Cordova plant. Treated wastewater from the WWTP is discharged to the Mississippi River under National Pollutant Discharge Elimination System (NPDES) permit # IL0003140 issued by the Illinois EPA to 3M. As shown on Figure 2-3, the remainder of the property is former agricultural land (now green space), some of which was historically used for land incorporation of sludge generated by the WWTP (from 1975-1999). Land incorporation of WWTP sludge was performed by 3M in accordance with the terms of a Sludge Incorporation Permit issued by the Illinois EPA to 3M. As of January 1, 2000, all sludge produced at the WWTP has been disposed of off-site at permitted industrial waste landfills.

A high capacity production well network supplies the 3M facility with process and non-contact cooling water, and is located on the undeveloped portion of the Site east of Illinois Route 84. It currently consists of six groundwater production wells (long-time production wells PW-11 and PW-37; plus newer production wells PW-91, PW-94, PW-112 and PW-113) that range in depths from 117 to 183 feet below ground surface (ft bgs). Production well locations are depicted on Figure 2-3. The well field was designed to meet a plant demand of 10 to 12 million gallons per day (mgd). Individual flow rates for the production wells recorded in April and October 2018 are provided on Figures 4-2 and 4-3 in Section 4



of this report. A table summarizing available well construction and other information for the Site production and monitoring wells is included in Attachment A.

Detailed information on the Site environmental setting and operational history has been presented in *Environmental Assessment for Perfluorochemicals (PFCs) Summary Report, 3M Cordova, Illinois Facility* (3M, April 2014a).



Legend

Site Boundary



Figure 2-1
Site Location Map
3M Cordova Facility
Cordova, Illinois

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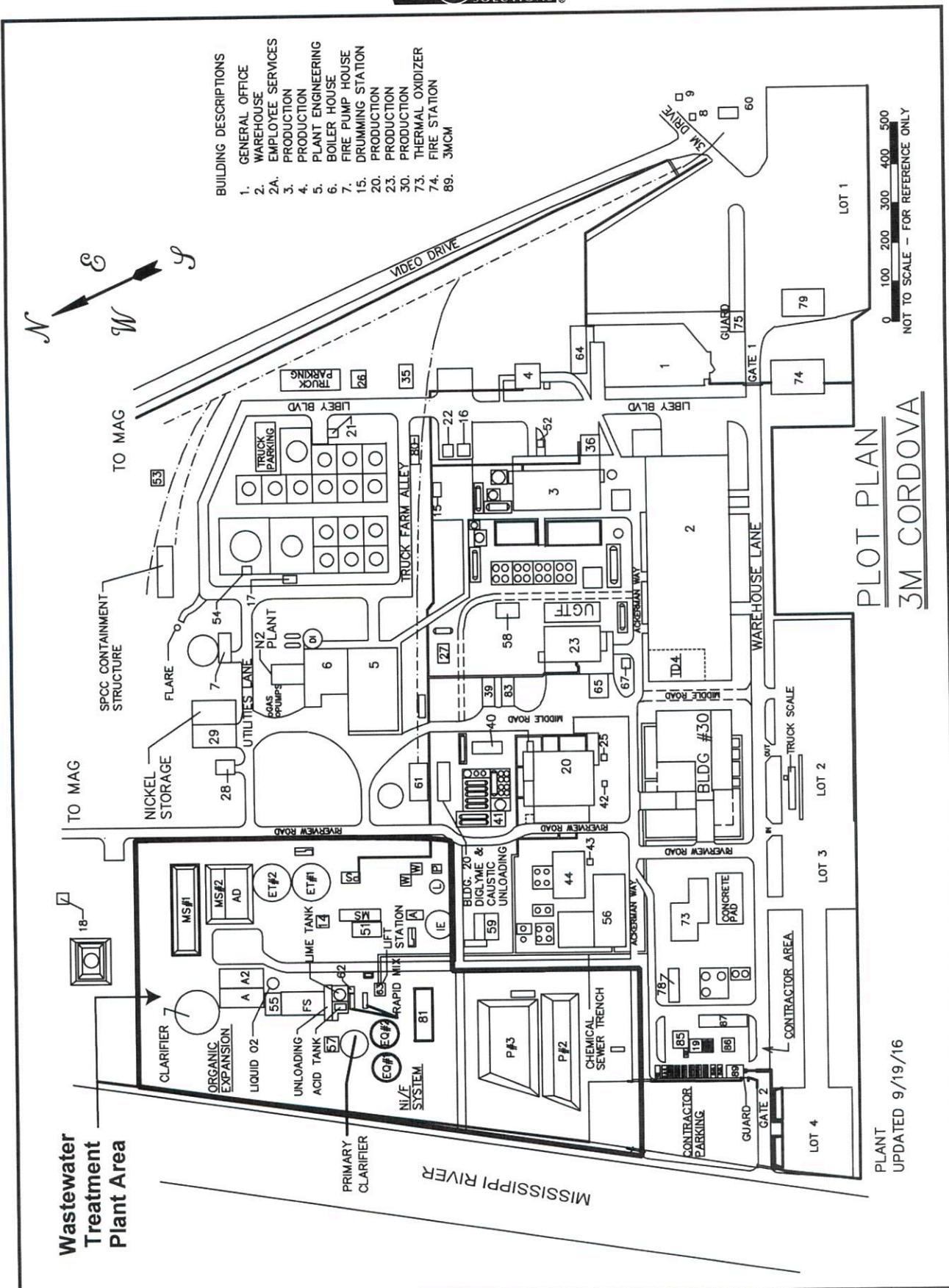


FIGURE 2-2 SITE LAYOUT, MANUFACTURING AREA
3M CORDOVA, ILLINOIS



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Appendix RCRA B
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Legend

- Production Well Location
- Former Sludge Incorporation Area Zones
- Site Boundary
- 3M Cordova
- Cordova, Illinois

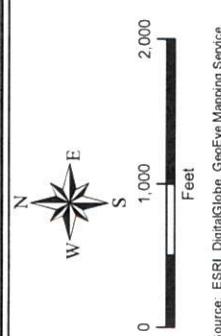


Figure 2-3
Former Sludge Incorporation Zones
and Production Well Locations
Cordova Site
Cordova, IL

Imagery Source: ESRI, DigitalGlobe, GeoEye Mapping Service.

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3. GROUNDWATER SAMPLING PROGRAM

In accordance with the GMZ Groundwater Sampling Plan, groundwater samples were collected semiannually from Site production and monitoring wells. In addition, per the Plan, groundwater samples were collected annually from residential wells in the area. Groundwater samples were delivered under chain-of-custody documentation to the 3M Environmental Laboratory in St. Paul, MN for PFAS analyses.

3.1 PRODUCTION AND MONITORING WELL SAMPLING

The current groundwater monitoring network at the Site, and within the GMZ, consists of 36 monitoring wells and 6 piezometers. In addition, there are currently six existing production wells (PW-11, PW-37, PW-91, PW-94, PW-112 and PW-113) that operate on a consistent basis. Production well PW-24 is not currently operating due to pump mechanical problems, and is scheduled to be replaced in 2019. During the sampling event performed in April 2018, production wells PW-11, PW-94, PW-112 and PW-113 were operating continuously, and production wells PW-37 and PW-91 were operating intermittently. During the sampling event performed in October 2018, production wells PW-11, PW-37, PW-91, PW-94, PW-112 and PW-113 were operating continuously.

The monitoring and production wells that are included in the GMZ groundwater sampling network for PFAS are presented in Table 3-1 and shown on Figure 3-1. In addition, the locations of residences sampled are shown on Figure 3-1. In accordance with the GMZ Sampling Plan, groundwater samples collected from monitoring, production and residential wells were analyzed for PFOA, PFOS, perfluorobutanoic acid (PFBA), perfluorobutane sulfonate (PFBS) and perfluorohexane sulfonate (PFHS).

3.2 RESIDENTIAL WELL SAMPLING

As presented in the October 2010 Work Plan Addendum No. 2, seven residential wells within 0.5 mile of the 3M property were identified by 3M and WESTON (Figure 3-1). 3M worked with Illinois EPA staff to prepare and send notification letters seeking permission



from residents to collect groundwater samples from their wells. Subsequently, the first round of residential groundwater samples was collected on July 18, 2011.

Per the Illinois EPA-approved February 2012 Update Report, a second sampling of the residential wells was performed in August 2012. Since 2012, 3M has continued to contact the property owners each year to continue annual well sampling which is performed on a voluntary basis. Occasionally, despite numerous attempts by 3M and Weston to obtain permission to access a property to obtain a water sample, permission is not obtained from the property owner and the wells are not sampled. Table 4-4, included in Section 4 of this report, documents each residential well, years sampled and sampling results.

In October 2018, a water sample could not be collected from residential well 23321 (current Miller residence). Numerous attempts to contact the owner of the property were made by 3M; however, no response was received from the property owner and permission to collect a water sample was not obtained by 3M.

The groundwater samples from the residential wells were collected from readily accessible outdoor spigots. If a garden hose was attached to a spigot, it was removed before sample collection. The spigot was then opened and the water was purged for approximately 5 minutes prior to filling the laboratory prepared sample containers.

In addition to obtaining permission from residents to collect samples from their supply wells, 3M has consistently provided the analytical results, once finalized, to the individual residents. Illinois EPA staff have also been copied on these written correspondences.

3.3 GROUNDWATER ELEVATION MEASUREMENTS

As specified in the GMZ Groundwater Sampling Plan, depth-to-groundwater measurements were recorded at all accessible monitoring well and piezometer locations during the April and October 2018 sampling events. In addition, flow rates were recorded at the operating production wells. Water level measurements could not be recorded at the pumping wells due to the risk of getting the depth-to-water meter probe stuck to downhole equipment (i.e., pumps, piping, wiring). Figure 3-2 shows the locations of the monitoring wells and



piezometers where depth-to groundwater measurements were collected in accordance with the GMZ Groundwater Sampling Plan. The groundwater elevation data collected from the Site monitoring well network were used to prepare groundwater elevation contour maps. These data and maps are presented in Section 4.1.2.



Figure 3-1
PFC Groundwater Sampling Locations
Cordova Site
Cordova, IL

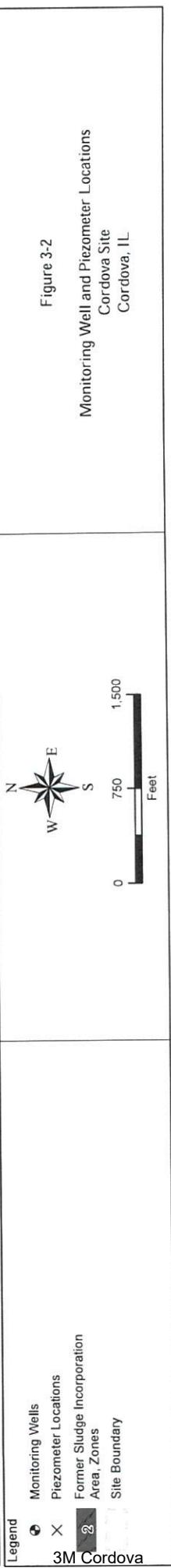
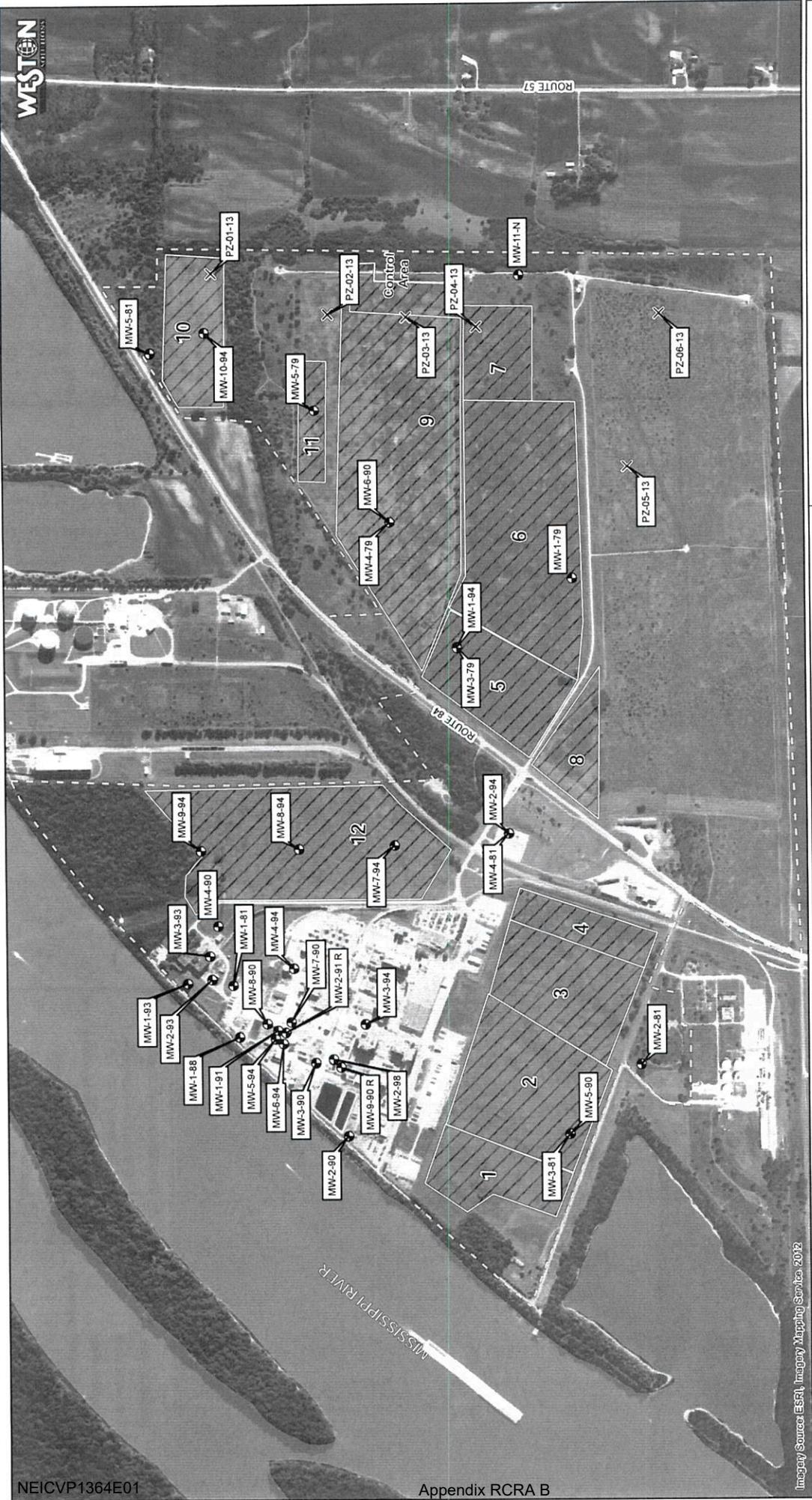




Table 3-1
GMZ Groundwater Monitoring Plan for PFAS
Cordova Site, Cordova, IL

Area	Well ID	Frequency	Comments
Manufacturing Area	MW-1-81	Semiannually	Northern edge of manufacturing area
	MW-1-88	Semiannually	Western perimeter of manufacturing area
	MW-1-90	Abandoned	Originally included in GMZ monitoring program; however, this well had to be abandoned due to plant construction activities.
	MW-2-90	Semiannually	Southwestern area of manufacturing area
	MW-7-90	Semiannually	Central area of manufacturing area
	MW-9-90R	Semiannually	Central area of manufacturing area
	MW-1-93	Semiannually	North of manufacturing area
	MW-3-94	Semiannually	South-central area of manufacturing area
	MW-4-94	Semiannually	East-central area of manufacturing area
Former Sludge Incorporation Area (SIA)	MW-1-79	Semiannually	Zone 6 of former SIA
	MW-3-79	Semiannually	Zone 5 of former SIA
	MW-4-79	Semiannually	Zone 9 of former SIA
	MW-5-79	Semiannually	Zone 11 of former SIA
	MW-3-81	Semiannually	Zone 2 of former SIA
	MW-7-94	Semiannually	Zone 12 of former SIA (south); east of manufacturing area
	MW-8-94	Semiannually	Zone 12 of former SIA (central); east of manufacturing area
	MW-9-94	Semiannually	Zone 12 of former SIA (north); east of manufacturing area
Site Production Wells	PW-11	Semiannually	Monitored since August 2006
	PW-12	Abandoned	Well decommissioned in 2013; replaced with PW-112
	PW-13	Abandoned	Well decommissioned in 2014; replaced with PW-113
	PW-24	Semiannually	Monitored August 2006 through October 2014. Well not operating since April 2015.
	PW-37	Semiannually	Monitored since August 2006
	PW-91	Semiannually	On-line in November 2012, monitored since June 2013
	PW-94	Semiannually	Monitored since December 2009
	PW-112	Semiannually	Monitored since November 2013
On-Site Reference Wells	PW-113	Semiannually	On-line in, and monitored since, October 2014
	MW-2-81	Semiannually	Southern property boundary; south of Zone 3
	MW-4-81	Semiannually	Southeast (downgradient) of manufacturing area
Residential Wells	MW-5-81	Semiannually	Northeast property boundary; north of Zone 10
	23321	Annually	East/northeast of Site; monitored since July 2011
	22610	Annually	East of Site; monitored since July 2011
	22704	Annually	East of Site; monitored since July 2011
	22703	Annually	East of Site; monitored since July 2011
	22414	Annually	East of Site; monitored since July 2011
	22009	Annually	East/southeast of Site; monitored since July 2011
	21421	Annually	South of Site; monitored since July 2011

Notes:

1. Analytes to include PFBA, PFOA, PFBS, PFHS and PFOS.
2. Residential wells will be sampled only with permission of property owners.



4. GROUNDWATER MONITORING AND ANALYTICAL RESULTS

Under the GMZ program, the semiannual groundwater sampling events were performed in April and October 2018. The annual residential well groundwater sampling event was performed in October 2018. Groundwater elevation data were collected during each groundwater sampling event. A summary of the groundwater elevation data and analytical results for groundwater samples collected in 2018 from residential, production and monitoring wells is provided in the following sections.

4.1 GROUNDWATER ELEVATIONS

Depth-to-groundwater measurements were collected during the April and October 2018 groundwater sampling events from accessible Site monitoring wells and piezometers. The depth-to-groundwater measurements were converted to groundwater elevations to construct contour maps to assess groundwater flow directions in the uppermost water-bearing zone at the Site. The 2018 recorded depth-to-groundwater and calculated groundwater elevations for the wells and piezometers are summarized in Table 4-1 along with previously recorded data extending back to October 2006. A table summarizing available well construction and other information for the Site production and monitoring wells is included in Attachment A.

4.1.1 Groundwater Hydrographs

Hydrographs presenting groundwater elevations and monthly precipitation data over time are provided for select Site monitoring wells in Appendix B. As shown in these hydrographs, and in Table 4-1, significant fluctuations occur in groundwater elevations over time. Fluctuations greater than five feet have been measured in the groundwater elevations at 40 out of 42 wells and piezometers. Groundwater elevations were higher in October 2018 compared to April 2018 due to several significant precipitation events that occurred just prior to the October 2018 sampling event.

To aid in visualizing the hydraulic gradient across the Site over time, an additional hydrograph was constructed plotting groundwater elevation with distance from the Mississippi River for dates in 2015 through 2018 when groundwater elevations were



measured (see Figure 4-1). The transect used to create the hydrograph is shown on Figure 4-2. As shown on Figure 4-1, the past four years of groundwater elevation data indicates that higher water elevations are present in the Mississippi River and monitoring wells adjacent to the Mississippi River compared to monitoring wells and piezometers closer to the production wells.

Occasionally, the groundwater elevations in monitoring wells MW-7-90 and MW-4-94 in the central and eastern area of the manufacturing area are slightly higher than the groundwater elevation in monitoring well MW-6-94 that is closer to the Mississippi River. This is due to the low hydraulic gradient in the groundwater surface beneath the manufacturing area that is susceptible to slight gradient changes during periods of higher recharge after precipitation or snow melt events.

As shown on Figure 4-1, the slope in groundwater elevation across the transect line (shown on Figure 4-2) increases between monitoring well MW-6-90 and piezometer PZ-04-13. This is due to the pumping of nearby production wells PW-112 and PW-113 that are located to the east and south, respectively, of piezometer PZ-04-13. Additional discussion on groundwater flow directions at the Site is provided in the following subsection.

4.1.2 Groundwater Elevation Contour Maps

The groundwater elevation contour maps for the Site were constructed using KT3D (Tonkin and Larson, 2002; Karanovic, Tonkin and Wilson, 2009), a computer software program designed to contour groundwater elevation data while taking into account one or more pumping centers. KT3D uses a log-linear kriging algorithm that accounts for more tightly spaced groundwater elevation contours around pumping centers and is capable of performing particle-tracking to estimate capture zones (assuming two-dimensional horizontal flow) for pumping wells. KT3D calculates groundwater elevations in the vicinity of pumping centers using a standard analytical method (Thiem analytical method) accounting for the hydraulic gradients in each hydrostratigraphic unit. This approach (i.e. using KT3D) results in a more representative groundwater elevation contour map and capture zones as compared to including measurement of groundwater elevations in pumping wells that could overestimate capture zones.



Figures 4-2 and 4-3 present groundwater elevation contour maps for the Site constructed using KT3D for April and October 2018, respectively. Groundwater elevations collected in October 2018 were higher than the groundwater elevations measured in April 2018. As shown on both Figures 4-2 and 4-3, the direction of groundwater flow is from the Mississippi River to the Site production wells to the east. As discussed previously, the hydraulic gradient is low beneath the manufacturing area of the plant (immediately to the east of the Mississippi River), and gradually increases toward the production wells. The hydraulic gradient calculated from manufacturing area monitoring well MW-4-94 to piezometer PZ-05-13 (near production well PW-113) is 0.0021 (ft/ft) and 0.0020 (ft/ft) for April and October 2018, respectively.

Despite the distance of the Site production wells from the Mississippi River, groundwater flow across the Site property is controlled by a combination of factors. The first factor that affects groundwater flow across the Site, is that the Site production wells operate continuously at a combined flow of approximately 4,000 to 8,500 gpm that creates a wide depression in the groundwater surface. Another factor for the extensive influence of the production wells is due to the local hydrogeologic setting. The production wells are installed near a bedrock valley that exists close to the eastern boundary of the 3M Cordova property. This bedrock valley is referred to as the Meredosia Channel which was carved out by glacial processes. Figure 4-4 shows the approximate bedrock elevation determined using geophysical techniques within the Meredosia Channel in the Site area (McGinnis and Heigold, 1974).

Figure 4-5 shows the approximate location of the Meredosia Channel relative to the Site production wells. The Site monitoring wells within the plant area are installed in the unconsolidated sediments outside the bedrock valley, to the west. The Site production wells are closer to the center of the Meredosia Channel as determined by the geophysical data collected. The long-term pumping of the production wells creates a “drain” effect that induces a widespread cone of depression, which funnels groundwater flow toward the production wells. This “drain” effect is enhanced along the sides of the bedrock valley since the thickness of the highly permeable sands and gravels that fill the valley is lower along the sides. The reduction in aquifer thickness outside the bedrock valley results in a reduction in



aquifer transmissivity. This, in turn, increases the drawdown at the plant manufacturing area monitoring wells resulting from pumping of the production wells (i.e. drawdown is inversely proportional to transmissivity). Thus, the location of the production wells within the bedrock valley (with a greater aquifer thickness) relative to the plant manufacturing monitoring wells along the edge of the bedrock valley (with a much smaller aquifer thickness) corroborates the view that the production wells have an extensive influence on the local groundwater flow regime.

4.2 MONITORING AND PRODUCTION WELL SAMPLING RESULTS

Tables 4-2 through 4-4 provide a summary of the 2018 PFAS analytical results for groundwater samples collected from monitoring wells located in the manufacturing area, former SIA, and on-site reference areas (wells not within the manufacturing area or former SIA). Table 4-5 provides a summary of the 2018 PFAS analytical results for groundwater samples collected from Site production wells. In addition to the 2018 PFAS analytical results, historical PFAS data are included for comparison purposes. The 3M Environmental Laboratory analytical data packages for the 2018 sampling events are provided in Appendix C.

The PFAS analytical data for monitoring and production wells were evaluated to determine whether the data are following an increasing or decreasing trend, or stable over time. The analytical data were evaluated by applying the Mann-Kendall trend test (at an $\alpha = 0.05$ significance level) to PFOS, PFBS, PFOA, PFBA and PFHS concentrations for those Site monitoring wells where sufficient historical groundwater analytical data are available (i.e. five or more sampling events). The Mann-Kendall trend test is a non-parametric statistical procedure that is used for analyzing trends in data over time (Gilbert, 1987). Nonparametric methods require no assumptions regarding the underlying statistical distribution of the data. The outcome of the procedure depends on the ranking of individual data points and not the overall magnitude of the data points. The Mann-Kendall procedure can be used for data sets that include irregular sampling intervals, data below the detection limit, and trace or missing data. Outcomes of this test consist of the identification of statistically significant increasing trends, no statistically significant trend or statistically significant decreasing trend at the



specified significance level. In addition, a “not detected” (ND) qualifier was assigned when ≥ 75 percent of the PFAS analytical results are less than the laboratory quantitation limit (LQL) and at least the last 4 results are less than the LQL. These data were not analyzed using the Mann-Kendall trend test since it would not provide a meaningful analysis.

It should be noted that the value of this trend analysis may be somewhat limited in some cases. More specifically, factors to be considered when reviewing outputs include:

- With the exception of some of the production wells, the number of data points for monitoring locations continues to expand, but in some cases the number of data points is relatively low (i.e., $n \leq 10$).
- The time period (t) over which the data has been collected is limited (for some locations, t is approximately 5 years).
- The magnitude and nature of the system being monitored (i.e., relatively large groundwater zone) is such that there may be gradual oscillations in observed results based on seasonal and/or episodic (extreme weather event) variations.

Table 4-6 provides a summary of the results of the Mann-Kendall analysis. A discussion of the groundwater analytical results is provided in the following subsections by Site area.

4.2.1 Manufacturing Area Wells

Table 4-2 is a summary of the analytical results of the PFAS groundwater samples collected from the 8 monitoring wells located in the manufacturing area and included in the GMZ sampling program. As shown in Table 4-2, PFBA, PFOA, PFBS, PFHS and PFOS were detected above their respective LQLs in the monitoring wells sampled in the manufacturing area, with the exception of monitoring well MW-1-81 where PFOA and PFHS were not detected in 2018. PFBA is the highest PFAS concentration detected in the groundwater samples collected from monitoring wells within the manufacturing area.

A review of the PFAS analytical data presented in Table 4-2 indicates that the PFAS concentrations in monitoring wells along the northern and western perimeter of the



manufacturing area (MW-1-81, MW-1-93, MW-1-88, MW-2-90 and MW-4-94) are lower compared to the PFAS concentrations detected in monitoring wells within the middle portion of the manufacturing area (MW-7-90, MW-9-90R and MW-3-94). Further, the PFAS analytical results for 2018 are comparable to, or lower than, historical analytical results.

The Mann-Kendall trend test was applied to the PFAS analytical data for monitoring wells MW-1-88, MW-2-90, MW-9-90R, MW-1-93, MW-3-94, MW-1-81, MW-7-90 and MW-4-94. As shown in Table 4-6, the Mann-Kendall trend test results indicate no statistically significant trend identified in the PFAS analytical data for these monitoring wells except the following decreasing trends:

- PFBS, PFOA, PFBA and PFHS in monitoring well MW-1-88;
- PFOS, PFOA and PFHS in monitoring well MW-9-90R;
- PFOS, PFBS, PFOA, PFBA and PFHS in monitoring well MW-1-93;
- PFOS and PFHS in monitoring well MW-3-94;
- PFOS in monitoring well MW-1-81;
- PFBS, PFBA and PFHS in monitoring well MW-4-94;
- PFOS in monitoring well MW-7-90.

The Mann-Kendall trend test did not identify an increasing PFOS, PFBS, PFOA, PFBA or PFHS trend in any of the manufacturing area monitoring wells.

4.2.2 Former Sludge Incorporation Area (SIA) Monitoring Wells

Table 4-3 provides a summary of the analytical results of the PFAS groundwater samples collected from the 8 former SIA monitoring wells that are included in the GMZ sampling program. As shown on Figure 3-1, the former SIA monitoring wells sampled under the GMZ sampling program are distributed across the Site. The SIA monitoring wells are located in the following areas:



- Former SIA east of Highway 84: Monitoring wells MW-1-79, MW-3-79, MW-4-79 and MW-5-79;
- Immediately east of manufacturing area: Monitoring wells MW-7-94, MW-8-94 and MW-9-94;
- South of the manufacturing area: Monitoring well MW-3-81.

As shown in Table 4-3, PFBA, PFOA, PFBS, PFHS and PFOS were detected above their respective LQLs in monitoring wells sampled in the former SIA, with the exception of monitoring wells MW-4-79 and MW-5-79. PFBA and PFOS were the only PFAS detected in monitoring well MW-4-79 in the April and October 2018 sampling events. PFBA, PFOA and PFOS were detected at concentrations slightly above the respective LQL for these PFAS in monitoring well MW-5-79 in the April and October 2018 sampling events. Consistent with the PFAS results for the manufacturing area, PFBA is the highest PFAS detected in the groundwater samples collected from monitoring wells within the former SIA.

The highest total PFAS concentrations in the former SIA were detected at monitoring well MW-1-79. Monitoring well MW-1-79 is located hydraulically downgradient of the manufacturing area under pumping conditions. Groundwater elevation contour maps constructed for groundwater elevations collected in April and October 2018 (Figures 4-2 and 4-3, respectively) show the direction of groundwater flow is from the manufacturing area eastward toward the Site production wells where it is captured. Well MW-1-79 is directly in line with this manufacturing area to production well field flow path.

The northernmost monitoring wells within the former SIA continue to have the lowest PFAS levels. This is most evident in monitoring wells MW-4-79 and MW-5-79 in former SIA Zones 9 and 11, respectively. As shown in Table 4-3, PFAS levels in monitoring wells MW-4-79 and MW-5-79 are lower compared to the remainder of the former SIA monitoring wells (MW-1-79, MW-3-79, MW-7-94, MW-8-94, MW-9-94 and MW-3-81). Groundwater from beneath the manufacturing area, flowing east toward the production well network, may partly explain this condition.



The Mann-Kendall statistical analysis was applied to the PFAS analytical results for the former SIA monitoring wells. As shown in Table 4-6, the following statistical trends were observed:

- Monitoring well MW-1-79: A statistically significant decreasing trend was identified for PFOA, PFBA and PFHS. A statistically significant increasing trend was identified for PFOS. No statistically significant trend was identified for PFBS.
- Monitoring well MW-3-79: A statistically significant decreasing trend was identified for PFBS, PFOA, PFBA and PFHS. No statistically significant trend was identified for PFOS.
- Monitoring well MW-4-79: A statistically significant decreasing trend was identified for PFOS, PFOA, PFBA and PFHS. No statistically significant trend was identified for PFBS.
- Monitoring well MW-5-79: A statistically significant decreasing trend was identified for PFOS and PFBA. No statistically significant trend was identified for PFOA. PFBS and PFHS were not detected in the last 4 sampling rounds and ≥ 75 percent of the PFAS analytical results are less than the laboratory quantitation limit (LQL) for these compounds; therefore, the Mann-Kendall analyses was not applied to these PFAS compounds.
- Monitoring well MW-3-81: A statistically significant increasing trend was identified for PFOS, PFOA and PFHS, although the concentration of these compounds has been generally stable since 2015 (see analytical data in Table 4-3). No statistically significant trends were identified for PFBS or PFBA.
- Monitoring well MW-7-94: A statistically significant decreasing trend was identified for PFOA and PFBA. No statistically significant trends were identified for PFOS, PFBS or PFHS.



- Monitoring well MW-8-94: A statistically significant increasing trend was identified for PFOS. No statistically significant trends were identified for PFBS, PFOA, PFBA or PFHS.
- Monitoring well MW-9-94: A statistically significant decreasing trend was identified for PFOA. No statistically significant trends were identified for PFOS, PFBS, PFBA or PFHS.

4.2.3 On-Site Reference Wells

As shown in Figure 3-1, three on-site reference monitoring wells (MW-2-81, MW-4-81 and MW-5-81) are located outside both the plant manufacturing area and former SIAs. The PFAS analytical results for these monitoring wells are included in Table 4-4.

The 2018 PFAS analytical results for monitoring well MW-5-81 were below their respective LQL for PFOA, PFBS, PFHS and PFOS. PFBA was detected at low concentrations during the 2018 sampling events at MW-5-81. PFBA, PFBS and PFOS were detected at low concentrations during the April and October 2018 sampling events for the groundwater samples collected from monitoring well MW-2-81. Measurable PFAS concentrations were detected in the April and October 2018 events, but within historical levels, for monitoring well MW-4-81.

The groundwater elevation contour maps constructed for the Site provide a possible explanation for the distribution of PFAS compounds in the on-site reference wells. Monitoring well MW-4-81 is located hydraulically downgradient of the manufacturing area and former SIA Zones 1, 2, 3 and 4. Groundwater elevation contour maps (Figures 4-2 and 4-3) show groundwater flow from the manufacturing area and these former SIAs toward the Site production wells where it is captured. Monitoring wells MW-5-81 and MW-2-81 are not directly downgradient of either potential PFAS source area.

The Mann-Kendall statistical analysis was applied to the PFAS analytical results for the on-site reference wells. As shown in Table 4-6, the Mann-Kendall trend results indicate either no statistically significant trend was identified in the PFAS analytical data or the PFAS



analytical results were primarily not detected (“ND”) for the on-site reference wells except the following decreasing trends:

- PFOA and PFHS in monitoring well MW-4-81.

An increasing trend was identified for PFBA in monitoring well MW-4-81.

4.2.4 Site Production Wells

The 2018 PFAS groundwater sampling results for the groundwater samples collected from seven Site production wells is summarized in Table 4-5. Previous samples collected from these production wells, and historical data for abandoned production wells PW-12 and PW-13, are also included for comparison purposes. Production wells PW-11, PW-91, PW-94, PW-112 and PW-113 were the primary water supply wells for the plant in 2018. Production well PW-24 was not operable in 2018 due to pump mechanical issues; therefore, groundwater samples could not be collected from this well.

The highest 2018 PFAS concentrations were in the groundwater samples collected at production wells PW-113 and PW-94. Production well PW-113 was installed adjacent to production well PW-13 that was abandoned in 2014 due to a declining yield. Production well PW-113 was put on-line in late October 2014 as part of the plant water distribution system. As shown on Figures 4-2 and 4-3, production wells PW-113 and PW-94 are hydraulically downgradient of several SIAs and the manufacturing area. Therefore, PFAS concentrations in production well PW-113 are expected to be higher compared to other Site production wells. A review of the analytical results in Table 4-5 reveals that PFAS concentrations are lower in the samples collected from production wells PW-11, PW-24, PW-37 and PW-91 compared to the other production wells (i.e. PW-112, PW-113 and PW-94).

Over the last 5 years, 3M has invested in its production well network by replacing older wells that had diminished in capacity over time with new wells. Specifically, PW-12 was abandoned and replaced with PW-112 in 2013, and PW-13 was abandoned and replaced with PW-113 in 2014. In both instances, there was a significant period of downtime (8-10 months) where neither the old or the replacement well was on-line and replacement wells



were constructed in virtually the same location as the wells they replaced. From the earliest sampling of the production wells in 2006, PW-12 and PW-13 demonstrated the highest PFAS levels. The following factors may help explain this observation:

- They were essentially on a centerline of groundwater being drawn from the manufacturing area (and significant portions of the former SIA) into the cone of depression created by the well field.
- They were high-capacity wells.
- Their utilization rate was high.

Given this set of circumstances, it is not surprising to detect shifts in PFAS concentrations amongst the wells during transition periods. For example, there is a notable increase in PFOS levels in production wells PW-11 and PW-13 in 2013. The end of pumping in January 2013 from PW-12, a well located just north of PW-11 and just northeast of PW-13, may partially explain these increases. Another shift in PFAS concentrations can be seen in production well PW-94. Results for PFOA, PFHS and PFOS were less than limits of quantitation for samples collected starting in December 2009 until March 2014. Subsequently, these analytes were detected in June 2014 and then measured at higher concentrations in October 2014 through October 2018. A possible explanation for this occurrence is that the downtime of PW-12 in 2013 and the downtime of PW-13 in 2014 resulted in groundwater being drawn slightly south into PW-94. Another possible explanation is that the continued operation of this well (its use as an agricultural irrigation well had been discontinued for a period of time prior to 3M acquiring the property on which the well is located) has drawn groundwater containing PFAS compounds from the north and/or west. In summary, while certain shifts in concentrations are observed for some constituents amongst the production wells, the effective overall capture of impacted groundwater at the Site remains unchanged.

The Mann-Kendall statistical analysis was applied to the PFAS analytical results for the Site production wells that met the criteria described in Section 4.2. As shown in Table 4-6, the following statistical trends were observed:



- Production well PW-11: A statistically significant decreasing trend identified for PFOS, PFOA, PFBA and PFHS. PFBS concentrations have been primarily not detected.
- Production well PW-112: A statistically significant decreasing trend identified for PFOS, PFOA, PFBA and PFHS. No statistically significant trend was identified for PFBS.
- Production well PW-113: A statistically significant decreasing trend identified for PFOA and PFHS. No statistically significant trend identified for PFOS, PFBS or PFBA.
- Production well PW-37: A statistically significant decreasing trend identified for PFOA and PFBA. No statistically significant trend identified for PFOS, PFBS or PFHS.
- Production well PW-91: PFAS continue to be primarily not detected. A statistically significant decreasing trend was identified for PFBA and no statistically significant trend was identified for PFBS.
- Production well PW-94: A statistically significant increasing trend identified for PFOS, PFBS, PFOA, PFBA and PFHS.

Also presented in Table 4-5 are the PFAS analytical results for a water sample collected at a monitoring point located in either Building 1 or Building 10. These sampling locations are representative of the combined flows from the operating production wells at the time of sample collection. An inspection of the PFAS results for the combined flows indicates somewhat variable PFAS concentrations. This is to be expected given that the mix of water from various wells changes often based on pumping schedules, site water demand, etc. In addition, changes in production well pumping (e.g. replacements of PW-12 and PW-13 with PW-112 and PW-113, respectively, over the time period 2013-2014) have occurred that undoubtedly affected the water quality from the production well network. As shown in Table 4-5, PFAS concentrations in 2018 are within the range observed in the historical data, with



the exception of PFBS that was slightly higher (1.32 ppb) in October 2018 compared to previous results.

4.3 RESIDENTIAL WELL SAMPLE RESULTS

In accordance with the GMZ Sampling Plan, groundwater samples were collected from the residential well locations during the October 2018 annual sampling event. A water sample from residential well 23321 was not collected during the October 2018 sampling event as 3M made numerous attempts to contact the owner of the residence, but no reply was received and permission to access the well was not obtained. The October 2018 analytical results for the residential well sampling are summarized in Table 4-7. Previous analytical results for residential sampling rounds performed in July 2011 through October 2017 are also presented in Table 4-7 for comparison. All analytical results have been shared with residents as they have been finalized. The 3M Environmental Laboratory analytical data packages for the October 2018 sampling event are provided in Appendix C.

An inspection of Table 4-7 indicates that PFOA, PFBS, PFHS and PFOS analytical results for 2018 were below LQLs for all locations. As shown in Table 4-7, PFBA was detected at concentrations ranging from 0.388 ppb to 2.06 ppb in the groundwater samples collected from the residential well locations in 2018. These values are significantly below the established baseline Illinois EPA groundwater remediation objective of 20 ppb for PFBA.

The Mann-Kendall statistical analysis was applied to the PFAS analytical results for all residential wells sampled in 2018. As shown in Table 4-6, the Mann-Kendall trend test results indicate a statistically significant decreasing trend in PFBA concentrations for residential well 22009. No statistically significant trend in PFBA concentrations for residential wells 22703, 21421 and 22610, while a statistically significant increasing trend was identified for residential wells 22704 and 22414. As shown in Table 4-7, the PFBA analytical results for these wells are in the low ppb range and have fluctuated over a limited range in concentration. Furthermore, the 2018 PFBA results are comparable to historical PFBA concentrations at these two residential wells.



As shown in Figure 3-1, residential well 21421 is to the south of the plant manufacturing area and the former SIA. An examination of the groundwater elevation contours in Figures 4-2 and 4-3 indicates that residential well 21421 is hydraulically cross-gradient from the Site. The groundwater elevation contours and flow lines indicate no component of groundwater flow from the Site directly toward residential well 21421. Along the eastern Site boundary, groundwater elevation contours have consistently shown a steep depression in the groundwater table that results in groundwater flow from residential wells 22704 and 22414 toward the Site production wells (i.e., east-to-west).

In summary, the results observed through monitoring of the residential wells from 2011-2018 have been consistent. Most analytes have been “not detected” while PFBA has been measured at consistently low and somewhat variable levels. The variability observed is not unusual for this type of monitoring situation and the concentrations observed are well below criteria established by the Illinois EPA to be protective for a lifetime of consumption.

4.4 SITE NPDES WASTEWATER PERMIT MONITORING

Consistent with the site NPDES permit effective January 1, 2013, quarterly monitoring for PFAS compounds of the wastewater discharge is conducted. Table 4-8 presents a summary of the analytical results.

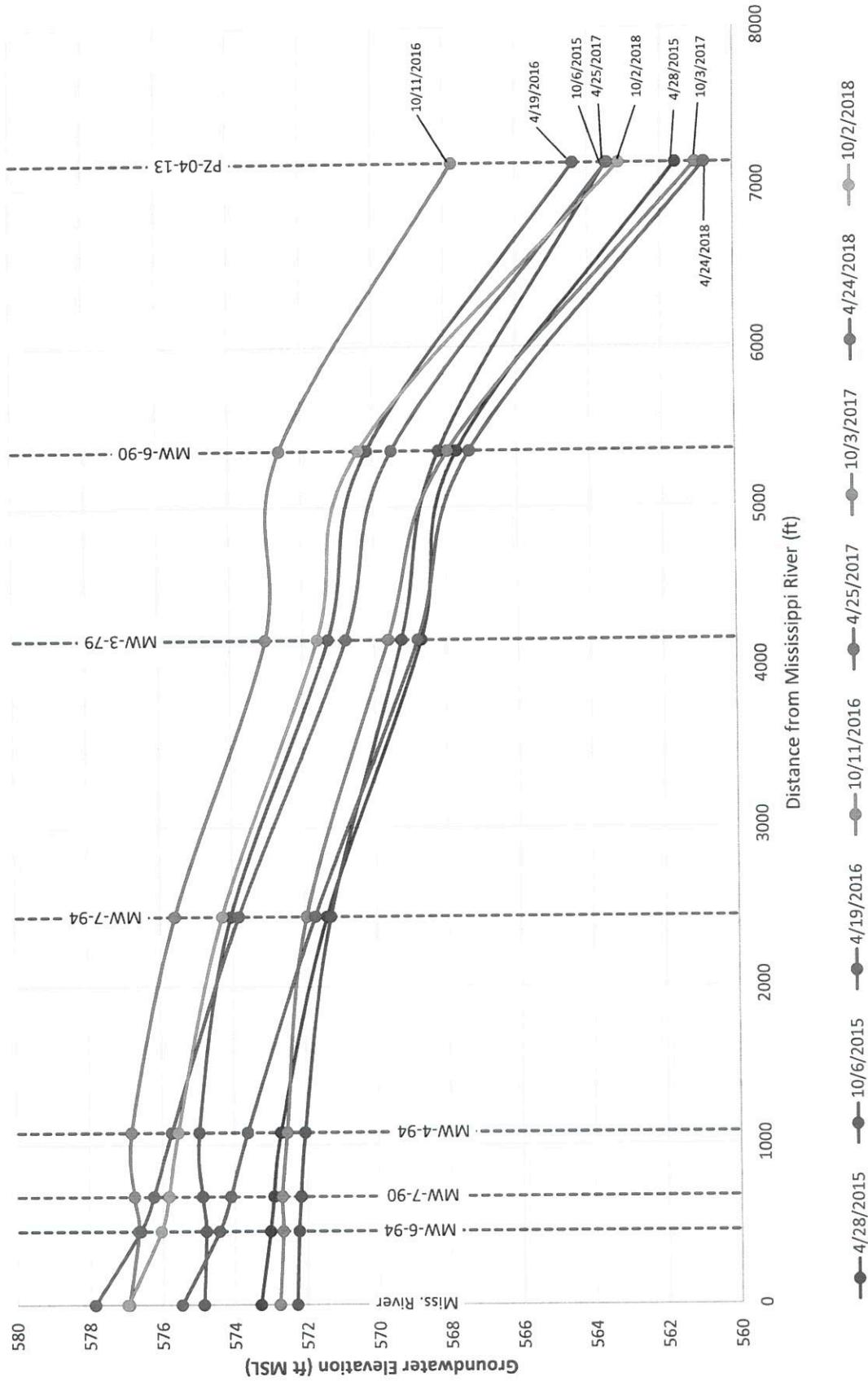
The following observations are noted relative to the data summarized in Table 4-8:

- The results have been below limits of quantitation for PFUnA, PFDoA, PFTrA and PFOSA.
- In 2018, PFBA concentrations ranged from 84.9 to 2390 ng/mL. The other detected constituents measured at concentrations \leq 32 ng/mL.

Monitoring will continue for the term of the permit.

Figure 4-1

**Groundwater Hydrograph
Groundwater Elevation vs. Distance from Mississippi River
June 2015 - October 2018
Cordova Site, Cordova, IL**



Note: Mississippi River water elevation obtained from USGS monitoring station in Camanche, IA.

2018-10-COIL-GW-Elev-DTW-rev_2019-01-29-DC-rev.xlsxDistance CHT(4yr)(fig4-1)

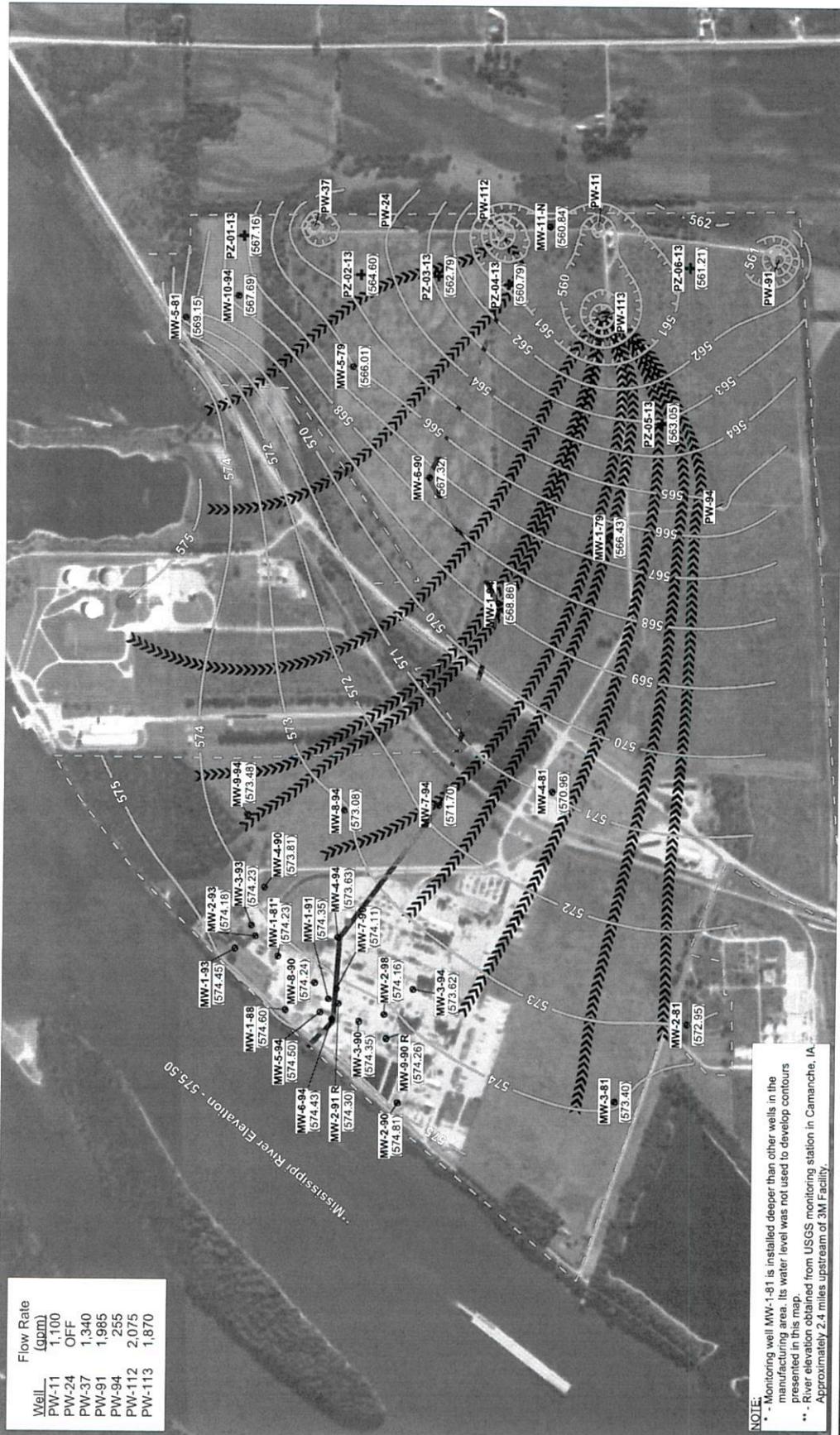


Figure 4-2
Groundwater Elevation Contour Map
24 April 2018
3M Cordova Facility
Cordova, IL



Legend

- Production Well Location (PW)
- Monitoring Well Location (MW)
- ✚ Piezometer Location (PZ)
- Groundwater Elevation Contour (contour interval 1 ft)
- (574.01) Groundwater Flow Path
- - - Property Boundary
- Hydograph Transect Line

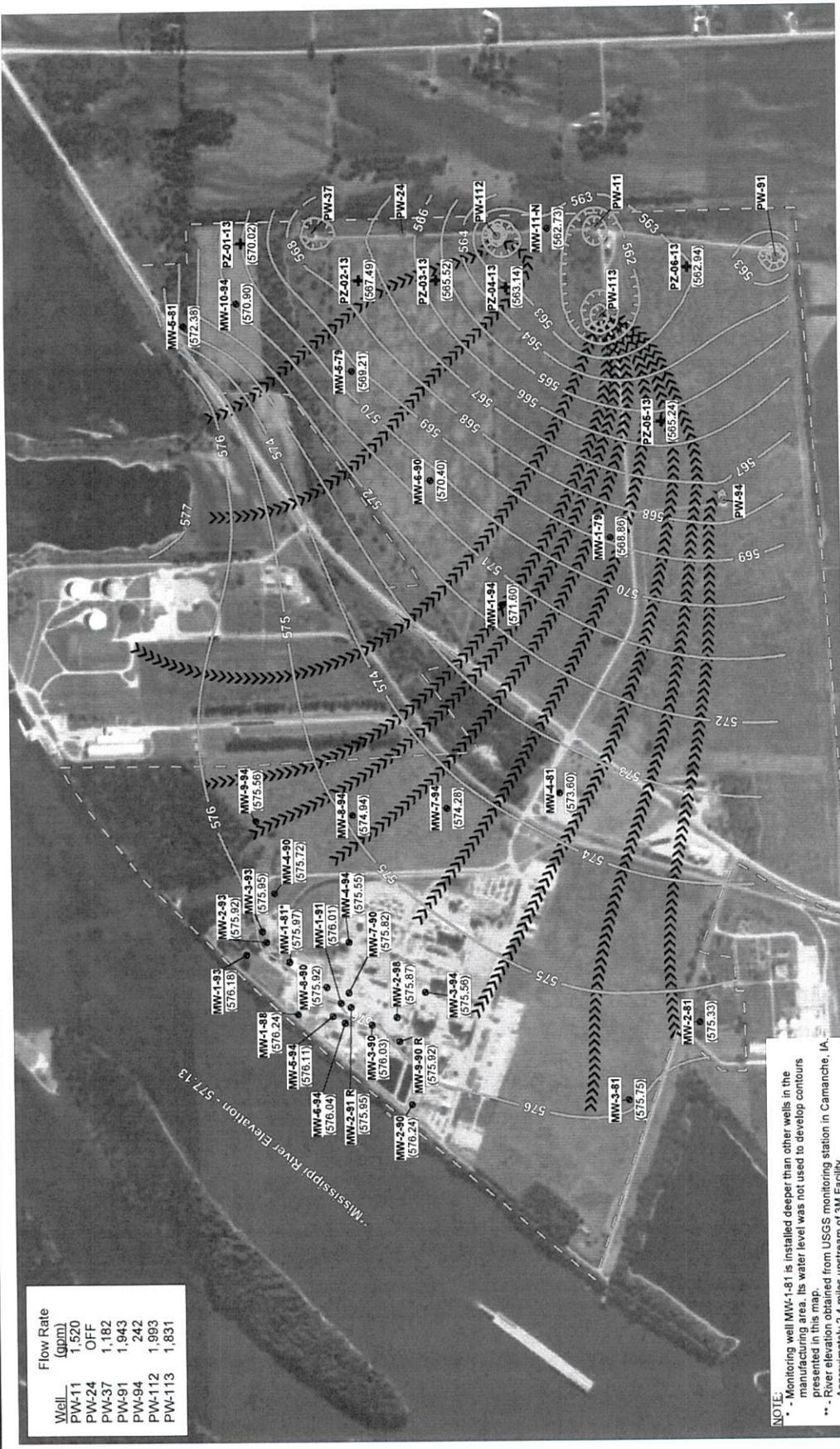


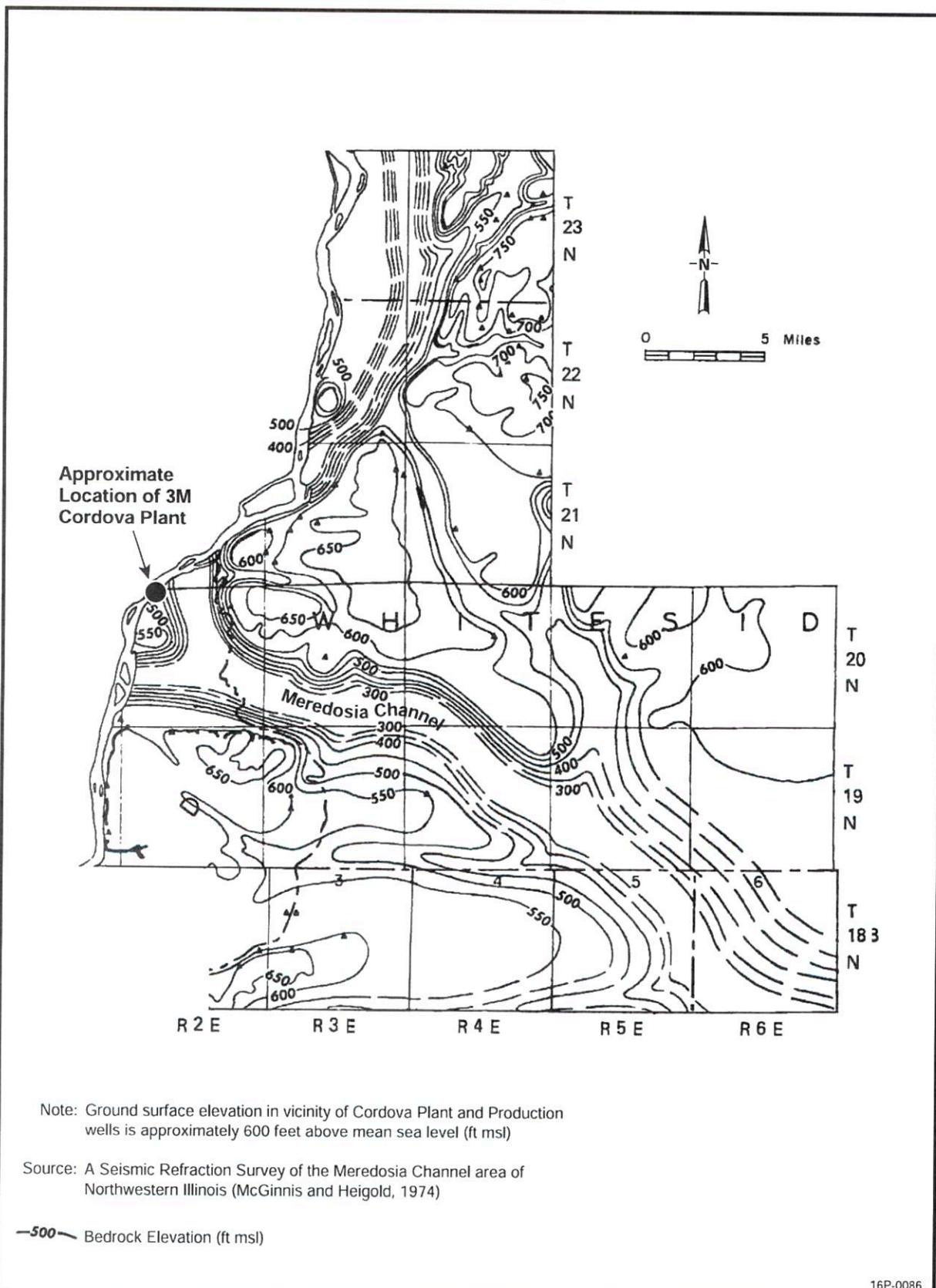
Figure 4-3
Groundwater Elevation Contour Map
2 October 2018
3M Cordova Facility
Cordova, IL

2018-1003-COIL-GWarp



Legend

- Production Well Location (PW)
- Monitoring Well Location (MW)
- ✚ Piezometer Location (PZ)
- Groundwater Elevation Contour (contour interval 1 ft)
- (572.38) Groundwater Elevation (ft MSL)
- Groundwater Flow Path
- Property Boundary



**FIGURE 4-4 BEDROCK ELEVATION OF THE MEREDOSIA CHANNEL
3M CORDOVA FACILITY
CORDOVA, ILLINOIS**



Legend

- Production Well Location (PW)
- Property Boundary
- Approximate Center of Meredosia Channel

Note: Location of Meredosia Channel is based on *A Seismic Refraction Survey of the Meredosia Channel Area of Northwestern Illinois (McGinnis and Heigold, 1974) and Buried Bedrock Surface of Illinois (Herzog et al., 1994)*.



Figure 4-5

**Production Well and Meredosia Channel Location Map
Cordova Site, Cordova IL**



Table 4-2
Summary of Groundwater PFAS Analytical Data
Manufacturing Area Monitoring Wells
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
MW-1-88	Mar 2008	17.5	0.519	NR	0.630	0.142
	Dec 2009	158	5.85	124	6.04	41.8
	Jun 2013	16.3	1.29	23.4	3.38	3.43
	Oct 2014	41.2	1.56	28.5	3.23	9.16
	Apr 2015	4.21	0.122	1.51	0.161	0.72
	Oct 2015	27.2	1.11	26.6	1.81	3.52
	Apr 2016	6.83	0.459	1.34	0.735	1.88
	Oct 2016	25.4	2.77	7.91	4.70	2.25
	Apr 2017	4.25	0.112	0.098	0.112	1.28
	Oct 2017	15.7	0.199	1.640	0.469	0.868
	Apr 2018	3.64	<0.0240	<0.0250	<0.0250	0.452
	Oct 2018	16.2	0.416	1.63	0.700	2.70
MW-2-90	Mar 2008	53.1	2.36	0.937	2.29	4.46
	Dec 2009	56.9	4.50	7.54	6.50	5.91
	Jun 2013	3.79	0.077	0.088	0.077	4.55
	Oct 2014	13.9	0.772	0.519	0.782	3.84
	Apr 2015	20.6	0.306	0.455	0.300	4.51
	Oct 2015	46.5	1.38	1.41	1.34	8.31
	Apr 2016	7.77	0.154	0.183	0.146	9.37
	Oct 2016	8.11	0.103	0.206	0.155	9.27
	Apr 2017	7.10	0.154	0.164	0.190	12.1
	Oct 2017	16.7	0.746	0.603	0.861	5.29
	Apr 2018	4.28	0.097	0.104	0.103	1.53
	Oct 2018	12.2	0.292	0.379	0.401	7.09
MW-9-90R	Mar 2008	103	1.70	2.87	2.47	27.2
	Dec 2009	372	6.09	76.1	4.82	107
	Jun 2013	99.8	1.86	1.84	2.43	40.2
	Jun 2014	1050	12.3	4.22	3.74	75.3
	Oct 2014	NA	NA	NA	NA	NA
	Apr 2015	213	2.11	2.43	2.02	34.5
	Oct 2015	192	1.82	2.32	2.01	30.5
	Apr 2016	112	1.19	1.02	1.53	31.6
	Oct 2016	116	2.43	1.76	2.86	64.8
	Apr 2017	35.0	0.480	1.39	0.724	16.8
	Oct 2017	261	0.787	5.42	1.06	23.2
	Apr 2018	101	0.475	4.01	0.765	14.2
	Oct 2018	114	0.931	2.05	0.775	15.4

COIL-SECURED: Table-04-01-to-4-5_COIL_2018-10_ISO18-0002_GW_Results



Table 4-2 (cont'd)
Summary of Groundwater PFAS Analytical Data
Manufacturing Area Monitoring Wells
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
MW-1-93	Mar 2008	22.0	0.709	0.470	3.78	4.52
	Dec 2009	10.7	0.497	0.217	1.60	5.75
	Jun 2013	8.05	0.269	0.117	0.420	3.03
	Oct 2014	22.5	0.18	0.259	0.841	3.31
	Apr 2015	10.5	0.15	0.127	0.804	1.84
	Oct 2015	17.4	0.208	0.202	1.15	4.41
	Apr 2016	27.9	0.323	0.37	0.753	1.82
	Oct 2016	8.40	0.148	0.091	0.479	2.99
	Apr 2017	2.74	0.044	0.047	0.052	0.377
	Oct 2017	9.68	0.174	0.266	1.14	2.16
	Apr 2018	4.08	0.052	0.094	0.270	0.937
	Oct 2018	2.61	0.026	0.059	0.060	0.340
MW-3-94	Mar 2008	734	7.61	120	11.4	51.8
	Dec 2009	290	6.66	238	8.97	76.2
	Jun 2013	217	3.19	17.4	3.21	52.7
	Jun 2014	213	2.42	20.8	1.97	41.7
	Oct 2014	239	5.00	38.9	3.75	107
	Apr 2015	350	3.45	52.3	1.52	57.1
	Oct 2015	658	5.75	64.5	5.45	38.4
	Apr 2016	403	5.12	33.1	3.59	29.2
	Oct 2016	342	9.53	43.7	6.21	41.9
	Apr 2017	174	4.80	15.4	1.49	20.5
	Oct 2017	148	3.19	46.1	2.73	36.8
	Apr 2018	104	0.899	38.3	0.765	10.2
MW-1-81	Oct 2018	381	2.24	33.2	3.25	24.4
	Jun 2013	1.44	0.108	0.078	0.071	0.247
	Oct 2014	0.615	<0.0240	0.066	0.041	0.061
	Apr 2015	0.250	<0.0240	0.029	<0.0500	0.058
	Oct 2015	0.138	<0.0240	<0.0250	<0.0236	0.070
	Apr 2016	<0.0250	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2016	<0.100	<0.0240	<0.0250	<0.0250	0.04
	Apr 2017	0.064	<0.0240	0.046	<0.0250	<0.0232
	Oct 2017	0.131	<0.0240	0.033	<0.0250	0.037
	Apr 2018	0.082	<0.0240	<0.0250	<0.0250	0.026
	Oct 2018	0.156	<0.0240	0.079	<0.0250	0.056

COIL-SECURED: Table-04-01-to-4-5_COIL_2018-10_ISO18-0002_GW_Results



Table 4-2 (cont'd)

Summary of Groundwater PFAS Analytical Data
Manufacturing Area Monitoring Wells
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
MW-4-94	Jun 2013	88.3	2.29	14.0	5.06	17.7
	Oct 2014	51.0	1.83	9.48	3.41	16.8
	Apr 2015	46.4	1.46	6.52	3.41	19.1
	Oct 2015	40.0	1.11	2.81	3.32	12.2
	Apr 2016	25.3	1.50	4.15	3.58	10.4
	Oct 2016	24.9	1.03	1.48	2.83	2.57
	Apr 2017	21.4	2.40	2.41	5.79	15.7
	Oct 2017	24.1	0.661	1.72	1.25	9.23
	Apr 2018	29.8	1.24	2.19	2.29	12.7
	Oct 2018	25.3	1.37	2.40	2.64	12.3
MW-7-90	Jun 2013	13.7	0.946	0.738	2.85	65.6
	Jun 2014	26.1	1.35	0.886	3.17	68.8
	Oct 2014	55.9	1.90	3.56	6.69	73.4
	Apr 2015	30.2	1.07	1.06	4.00	32.5
	Oct 2015	36.3	1.43	2.10	4.19	28.8
	Apr 2016	26.9	1.08	0.512	3.26	29.9
	Oct 2016	37.2	1.72	0.80	5.11	48.7
	Apr 2017	29.2	1.19	0.649	3.81	34.1
	Oct 2017	43.1	1.08	1.86	3.90	32.1
	Apr 2018	39.1	0.841	1.01	2.63	19.6
	Oct 2018	34.5	0.741	1.22	2.63	26.0

NR - Not reported due to quality control failure.

NA - Not available. Not sampled due to construction activities in area.

Concentrations reported are the average of primary and duplicate sample analytical results



Table 4-3
Summary of Groundwater PFAS Analytical Data
Former Sludge Incorporation Area (SIA) Monitoring Wells
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
MW-1-79	Mar 2008	135	6.60	2.50	9.72	22.2
	Dec 2009	240	21.0	2.57	14.3	24.4
	Jun 2013	152	14.0	2.89	17.1	29.6
	Jun 2014	174	9.5	6.8	11.4	33.0
	Oct 2014	184	6.2	41.8	9.5	45.9
	Apr 2015	166	5.34	33.7	9.16	43.4
	Oct 2015	157	4.85	35.3	7.45	37.3
	Apr 2016	94.7	2.68	20.9	4.28	32.3
	Oct 2016	93.9	1.93	14.0	4.02	33.5
	Apr 2017	84.4	1.91	9.49	3.62	33.9
	Oct 2017	91.7	2.73	7.55	3.99	37.8
	Apr 2018	90.3	2.50	7.85	4.01	40.1
	Oct 2018	94.6	2.46	9.12	4.56	37.9
MW-3-79	Mar 2008	32.0	2.17	0.756	3.95	3.22
	Dec 2009	81.1	4.10	19.8	7.55	16.9
	Jun 2013	54.4	2.87	12.9	5.93	13.9
	Oct 2014	31.1	1.46	0.574	1.67	31.0
	Apr 2015	21.0	0.901	0.368	1.34	13.9
	Oct 2015	20.6	0.815	0.480	1.12	12.5
	Apr 2016	10.9	0.388	0.172	0.698	8.34
	Oct 2016	12.8	0.379	0.100	0.754	11.8
	Apr 2017	10.8	0.296	0.166	0.593	8.09
	Oct 2017	13.9	0.362	0.141	0.735	10.3
	Apr 2018	14.6	0.402	0.185	0.832	10.2
	Oct 2018	13.4	0.326	0.184	0.960	13.3
MW-4-79	Mar 2008	1.22	0.032	0.025	0.034	0.079
	Dec 2009	8.35	0.123	0.053	0.046	0.174
	Jun 2013	3.16	0.154	0.086	0.275	0.121
	Jun 2014	5.26	0.219	0.097	0.314	0.151
	Oct 2014	5.69	0.127	0.089	0.203	0.111
	Apr 2015	4.57	0.051	0.071	0.057	0.081
	Oct 2015	5.52	0.061	0.105	0.080	0.169
	Apr 2016	2.87	0.061	0.090	0.062	0.145
	Oct 2016	1.49	<0.024	<0.0250	<0.0250	0.0553
	Apr 2017	0.639	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	0.691	<0.0240	<0.0250	<0.0250	<0.0232
	Apr 2018	0.571	<0.0240	<0.0250	<0.0250	0.034
	Oct 2018	0.383	<0.0240	<0.0500	<0.0250	0.034

COIL-SECURED: Table-04-01-to-4-5_COIL_2018-10_ISO18-0002_GW_Results



Table 4-3 (cont'd)
Summary of Groundwater PFAS Analytical Data
Former Sludge Incorporation Area (SIA) Monitoring Wells
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
MW-5-79	Mar 2008	0.400	<0.0298	<0.0249	<0.0244	< 0.0250
	Dec 2009	<2.50	0.087	0.027	<0.0250	0.055
	Jun 2013	0.528	0.026	<0.0250	<0.0250	0.045
	Jun 2014	0.571	<0.0240	<0.0250	<0.0250	0.035
	Oct 2014	0.19	<0.0240	<0.0250	<0.0250	0.054
	Apr 2015	0.153	<0.0240	<0.0250	<0.0500	0.025
	Oct 2015	0.255	<0.0240	<0.0250	<0.0236	0.044
	Apr 2016	0.085	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2016	<0.100	<0.0240	<0.0250	<0.0250	<0.0232
	Apr 2017	<0.0500	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	0.156	<0.0240	<0.0250	<0.0250	<0.0232
	Apr 2018	0.111	<0.0240	<0.0250	<0.0250	0.027
	Oct 2018	<0.100	0.035	<0.0500	<0.0250	0.033
MW-3-81	Mar 2008	41.3	3.56	0.189	4.32	5.94
	Dec 2009	48.7	5.19	0.357	5.40	7.54
	Jun 2013	40.0	3.98	0.356	6.95	25.5
	Jun 2014	60.3	5.84	0.371	8.67	31.5
	Oct 2014	61.0	5.97	0.635	10.7	31.7
	Apr 2015	65.0	7.22	0.424	14.4	51.3
	Oct 2015	68.2	7.85	0.410	13.8	41.8
	Apr 2016	48.5	5.75	0.305	11.1	38.2
	Oct 2016	52.2	7.26	0.33	12.9	51.3
	Apr 2017	50.4	6.56	0.342	12.0	40.8
	Oct 2017	49.4	6.62	0.335	13.2	42.1
	Apr 2018	47.5	6.63	0.290	12.9	42.4
	Oct 2018	48.7	6.79	0.431	13.8	40.4
MW-7-94	Mar 2008	53.7	2.45	0.821	4.98	11.0
	Dec 2009	63.4	7.23	1.90	7.68	20.8
	Jun 2013	28.3	2.04	0.311	4.45	5.44
	Jun 2014	84.2	2.46	25.2	3.07	22.1
	Oct 2014	85.7	1.50	20.0	2.88	17.3
	Apr 2015	40.5	0.719	0.718	2.39	11.7
	Oct 2015	67.9	1.21	6.07	3.21	19.3
	Apr 2016	35.3	1.03	4.16	2.44	13.2
	Oct 2016	36.4	1.04	2.52	2.82	18.8
	Apr 2017	35.0	1.03	2.23	3.30	18.3
	Oct 2017	35.7	0.910	1.98	3.25	18.7
	Apr 2018	28.1	0.967	2.86	3.22	8.43
	Oct 2018	27.5	0.902	2.10	2.40	10.5

COIL-SECURED: Table-04-01-to-4-5_COIL_2018-10_ISO18-0002_GW_Results



Table 4-3 (cont'd)
Summary of Groundwater PFAS Analytical Data
Former Sludge Incorporation Area (SIA) Monitoring Wells
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
MW-8-94	Mar 2008	98.4	4.00	1.05	NR	1.34
	Dec 2009	67.6	12.2	1.04	15.3	1.27
	Jun 2013	39.3	3.23	0.480	3.15	7.30
	Oct 2014	14.1	0.647	0.162	1.08	7.81
	Apr 2015	19.5	0.402	0.178	0.847	3.72
	Oct 2015	21	0.408	0.175	0.919	3.34
	Apr 2016	23.4	0.634	0.207	1.41	15.2
	Oct 2016	27.3	0.806	0.205	1.93	15.5
	Apr 2017	28.1	0.734	0.269	2.54	18.0
	Oct 2017	30.2	1.16	0.269	3.38	23.4
	Apr 2018	17.7	0.324	0.263	0.850	6.33
	Oct 2018	17.3	0.745	0.269	1.99	28.3
MW-9-94	Mar 2008	14.8	0.099	0.199	0.763	0.088
	Dec 2009	63.5	4.80	0.894	6.91	1.93
	Jun 2013	46.8	1.88	5.41	2.99	13.1
	Oct 2014	46.4	1.62	0.398	5.32	11.4
	Apr 2015	18.9	0.786	0.151	2.53	7.39
	Oct 2015	17.2	0.767	0.138	2.32	6.2
	Apr 2016	11.2	0.371	0.099	1.28	6.49
	Oct 2016	22.2	0.368	0.155	1.51	11.0
	Apr 2017	18.1	0.353	0.148	1.74	13.1
	Oct 2017	30.2	0.613	0.250	2.56	12.6
	Apr 2018	17.4	0.473	0.158	1.49	7.98
	Oct 2018	12.3	0.244	0.158	0.920	9.23

NR - Not reported due to quality control failure.

Concentrations reported are the average of primary and duplicate sample analytical results



Table 4-4
Summary of Groundwater PFAS Analytical Data
On-Site Reference Monitoring Wells
March 2008–October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
MW-2-81	Mar 2008	2.34	<0.0298	0.260	<0.0293	< 0.0250
	Dec 2009	6.04	0.034	0.870	<0.0250	0.054
	Jun 2013	3.92	<0.0240	0.163	<0.0250	0.061
	Oct 2014	2.60	<0.0240	0.077	<0.0250	0.103
	Apr 2015	1.34	<0.0240	0.036	<0.0500	0.061
	Oct 2015	1.66	<0.0240	<0.0250	<0.0236	0.114
	Apr 2016	1.57	<0.0240	0.037	<0.0250	0.057
	Oct 2016	1.67	<0.0240	<0.0250	<0.0250	0.100
	Apr 2017	1.43	<0.0240	<0.0250	<0.0250	0.087
	Oct 2017	1.44	<0.0240	0.098	<0.0250	0.067
	Apr 2018	1.38	<0.0240	0.089	<0.0250	0.068
	Oct 2018	4.74	<0.0240	0.064	<0.0250	0.057
MW-4-81	Mar 2008	145	12.1	0.829	11.6	13.7
	Dec 2009	155	6.26	7.73	6.99	21.5
	Jun 2013	140	5.80	5.88	7.49	22.5
	Oct 2014	191	6.05	13.5	9.86	39.3
	Apr 2015	254	5.63	15.6	9.96	40.5
	Oct 2015	326	6.69	18.7	9.89	37.5
	Apr 2016	165	4.44	10.5	6.99	29.6
	Oct 2016	171	4.82	12.0	7.67	33.0
	Apr 2017	211	4.21	9.83	7.80	32.1
	Oct 2017	219	3.41	9.66	6.65	25.4
	Apr 2018	253	2.94	7.16	5.92	25.3
	Oct 2018	216	2.64	7.48	5.80	24.2
MW-5-81	Mar 2008	0.135	<0.0298	<0.0249	<0.0244	<0.0250
	Dec 2009	0.089	<0.0303	<0.0255	<0.0250	<0.0253
	Jun 2013	0.074	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2014	<0.0250	<0.0240	<0.0250	<0.0250	<0.0232
	Apr 2015	<0.100	<0.0240	<0.0250	<0.0500	0.035
	Oct 2015	0.108	<0.0240	<0.0250	<0.0236	0.069
	Apr 2016	0.044	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2016	<0.100	<0.0240	<0.0250	<0.0250	<0.0232
	Apr 2017	<0.0500	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	<0.500	<0.0240	<0.0250	<0.0250	<0.0232
	Apr 2018	0.163	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2018	0.181	<0.0240	<0.0500	<0.0250	<0.0232

Concentrations reported are the average of primary and duplicate sample analytical results



Table 4-5
Summary of Groundwater PFAS Analytical Data
Site Production Wells and Combined Discharge Monitoring Point
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
PW-11	Aug 2006	---	0.200	---	---	0.400
	Mar 2008	2.22	0.066	<0.0249	0.094	0.266
	Dec 2009	2.09	0.118	<0.0255	0.111	0.278
	Jun 2013	1.52	0.183	<0.0250	0.190	2.42
	Nov 2013	2.00	0.139	<0.0250	0.144	1.87
	Dec 2013	2.26	0.146	0.029	0.159	1.66
	Mar 2014	1.87	0.090	<0.0500	0.098	1.01
	Jun 2014	2.13	0.144	0.039	0.140	1.56
	Oct 2014	2.51	0.199	<0.0250	0.213	2.65
	Apr 2015	0.357	<0.0240	<0.0250	<0.0500	<0.0232
	Oct 2015	1.53	<0.0240	<0.0250	<0.0236	0.025
	Apr 2016	0.766	<0.0240	<0.0250	<0.0250	0.085
	Oct 2016	0.772	<0.0240	<0.0250	<0.0250	0.038
	Apr 2017	0.791	<0.0240	<0.0250	<0.0250	<0.0232
PW-12 ¹	Oct 2017	0.963	<0.0240	<0.0250	<0.0250	0.026
	Apr 2018	1.06	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2018	0.805	<0.0240	<0.0500	<0.0250	0.056
	Aug 2006	---	0.700	---	---	2.90
	Mar 2008	3.89	0.500	<0.0249	0.530	2.91
PW-112 ¹	Dec 2009	4.41	1.38	0.039	1.23	11.3
	Nov 2013	6.43	1.19	0.051	1.33	25.8
	Dec 2013	6.51	1.21	0.066	1.29	28.9
	Mar 2014	5.3	0.96	<0.0500	1.06	25.3
	Jun 2014	3.92	0.778	0.041	0.785	12.8
	Oct 2014	4.49	0.725	0.042	0.81	13.9
	Apr 2015	1.83	0.215	<0.0250	0.256	6.29
	Oct 2015	1.52	0.191	<0.0250	0.28	3.95
	Apr 2016	1.39	0.225	<0.0250	0.33	6.97
	Oct 2016	1.47	0.201	<0.0250	0.317	7.82
	Apr 2017	1.69	0.261	<0.0250	0.434	14.4
	Oct 2017	1.28	0.199	<0.100	0.324	6.33
	Apr 2018	0.805	0.092	<0.0250	0.153	2.07
	Oct 2018	0.926	0.110	<0.0500	0.210	4.37
PW-13 ²	Aug 2006	---	4.60	---	---	11.8
	Mar 2008	60.9	4.16	1.82	4.84	11.4
	Dec 2009	57.4	7.93	1.63	6.46	14.8
	Jun 2013	39.7	5.58	1.80	6.61	44.6
	Nov 2013	64.7	8.36	3.71	10.4	42.9
	Dec 2013	61.8	7.29	3.06	8.73	45.1

COIL-SECURED: Table-04-01-to-4-5_COIL_2018-10_ISO18-0002_GW_Results



Table 4-5 (cont'd)

**Summary of Groundwater PFAS Analytical Data
Site Production Wells and Combined Discharge Monitoring Point
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL**

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
PW-113 ²	Oct 2014	118	4.05	14.8	7.64	27.8
	Apr 2015	35.4	2.99	1.67	4.58	35.8
	Oct 2015	34.5	2.39	2.35	3.57	26.1
	Apr 2016	22.6	1.86	1.87	2.66	23.6
	Oct 2016	27.0	2.08	2.42	2.89	32.2
	Apr 2017	28.3	2.21	3.03	3.05	35.8
	Oct 2017	30.6	1.81	4.49	2.65	36.4
	Apr 2018	28.4	1.39	4.42	2.06	29.1
	Oct 2018	29.1	1.25	5.25	2.02	25.2
PW-24	Aug 2006	---	0.400	---	---	1.70
	Mar 2008	2.61	0.455	<0.0249	0.445	3.49
	Dec 2009	1.45	0.347	<0.0255	0.408	0.727
	Jun 2013	1.29	0.242	<0.0250	0.291	5.93
	Nov 2013	1.26	0.333	<0.0250	0.420	5.50
	Dec 2013	1.56	0.290	0.030	0.386	3.45
	Jun 2014	0.37	0.059	<0.0250	0.064	0.53
	Oct 2014	0.63	0.177	<0.0250	0.249	1.73
	Apr 2015	NS	NS	NS	NS	NS
	Oct 2015	NS	NS	NS	NS	NS
PW-37	Aug 2006	---	0.600	---	---	0.200
	Mar 2008	1.39	0.449	<0.0249	0.283	0.383
	Dec 2009	1.39	0.342	<0.0255	0.401	0.698
	Jun 2013	0.521	0.223	<0.0250	0.293	1.46
	Nov 2013	0.949	0.243	<0.0250	0.350	2.31
	Dec 2013	1.05	0.264	0.031	0.361	2.42
	Mar 2014	0.749	0.193	<0.0500	0.209	1.62
	Jun 2014	0.418	0.066	<0.0250	0.072	0.51
	Oct 2014	0.62	0.177	<0.0250	0.258	1.73
	Apr 2015	1.78	0.219	<0.0250	0.262	6.40
	Oct 2015	NS	NS	NS	NS	NS
	Apr 2016	0.977	0.188	<0.0250	0.418	1.88
	Oct 2016	0.422	0.0624	<0.0250	0.133	0.822
	Apr 2017	0.489	0.139	<0.0250	0.266	1.55
	Oct 2017	0.561	0.115	<0.100	0.221	1.63
	Apr 2018	0.788	0.087	<0.0250	0.146	1.88
	Oct 2018	0.452	0.115	0.067	0.216	1.57

COIL-SECURED: Table-04-01-to-4-5_COIL_2018-10_ISO18-0002_GW_Results



Table 4-5 (cont'd)
Summary of Groundwater PFAS Analytical Data
Site Production Wells and Combined Discharge Monitoring Point
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
PW-91	Jun 2013	1.73	<0.0240	<0.0250	<0.0250	<0.0232
	Nov 2013	2.07	<0.0240	<0.0250	<0.0500	<0.0464
	Dec 2013	2.26	<0.0240	<0.0250	<0.0500	<0.0464
	Mar 2014	1.89	<0.0240	<0.0500	<0.0250	<0.0232
	Jun 2014	1.9	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2014	2.09	<0.0240	<0.0250	<0.0250	<0.0232
	Apr 2015	1.89	<0.0240	<0.0250	<0.0500	<0.0232
	Oct 2015	2.22	<0.0240	<0.0250	<0.0236	<0.0232
	Apr 2016	1.41	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2016	1.53	<0.0240	<0.0250	<0.0250	<0.0232
	Apr 2017	1.54	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	1.59	<0.0240	<0.0250	<0.0250	<0.0232
	Apr 2018	1.47	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2018	1.57	<0.0240	0.058	<0.0250	<0.0232
PW-94 ³	Dec 2009	5.11	<0.0303	0.060	<0.0250	<0.0253
	Jun 2013	4.76	<0.0240	0.069	<0.0250	<0.0232
	Nov 2013	4.86	<0.0240	0.057	<0.0500	<0.0464
	Dec 2013	5.39	<0.0240	0.073	<0.0500	<0.0464
	Mar 2014	6.07	<0.0240	0.070	<0.0250	<0.0232
	Jun 2014	6.53	0.068	0.098	0.086	0.238
	Oct 2014	17	2.48	0.470	4.38	13.5
	Apr 2015	28.4	3.06	0.798	6.36	30.3
	Oct 2015	22.7	1.59	1.54	2.39	12.6
	Apr 2016	32	2.33	3.24	4.16	30.2
	Oct 2016	31.2	2.73	1.46	4.80	37.7
	Apr 2017	26.2	2.47	0.848	4.55	33.8
	Oct 2017	25.5	2.03	0.740	3.79	29.9
	Apr 2018	17.3	1.50	0.251	2.96	27.5
	Oct 2018	19.3	1.68	0.299	3.65	34.8

COIL-SECURED: Table-04-01-to-4-5_COIL_2018-10_ISO18-0002_GW_Results



Table 4-5 (cont'd)
Summary of Groundwater PFAS Analytical Data
Site Production Wells and Combined Discharge Monitoring Point
March 2008-October 2018 Sampling Events
Cordova Site, Cordova, IL

Well ID	Average Sample Concentration (ng/ml, ppb)					
	Date Sampled	PFBA	PFOA	PFBS	PFHS	PFOS
<i>Combined Discharge Monitoring Point</i>						
Building 10 ⁴	Nov 2013	6.46	1.39	0.051	1.40	46.3
	Dec 2013	6.46	1.58	0.064	1.47	60.8
	Mar 2014	3.91	0.684	<0.0500	0.71	25.2
Building 1 ⁴	Jun 2014	2.71	0.320	0.033	0.312	4.81
	Oct 2014	4.13	0.541	0.067	0.781	6.66
	Apr 2015	13.5	1.19	0.621	1.99	15.2
	Oct 2015	13.4	0.886	0.801	1.30	9.81
	Apr 2016	6.14	0.445	0.474	0.787	6.35
	Oct 2016	9.94	0.770	0.626	1.24	13.1
	Apr 2017	9.33	0.771	0.693	1.22	14.9
	Oct 2017	8.90	0.563	1.05	0.873	11.6
	Apr 2018	7.36	0.379	0.953	0.597	7.60
	Oct 2018	8.66	0.385	1.32	0.674	8.18

¹ Production well PW-12 was permanently shut down in January 2013, replaced with PW-112 that went on-line in August 2013.

² Production well PW-13 was shut down in 2014 and replaced with PW-113 that went on-line in October 2014.

³ Former "Agricultural Well" #22580.

⁴ Building 1 and Building 10 include a monitoring point representative of the combined flows from operating production wells.

NS - Not sampled, pump not operable.

Concentrations reported are the average of primary and duplicate sample analytical results



Table 4-6

Mann-Kendall Trend Test Summary
PFOs, PFBS, PFOA, PFBA and PFHS
 Groundwater Analytical Data
 Cordova Site, Cordova IL

Well ID	Trend Analysis Data Range	PFOS		PFBS		PFOA		PFBA		PFHS	
		Number of Data Points	Trend								
<i>Manufacturing Area Monitoring Wells</i>											
MW-1-88	03/2008 - 10/2018	12	NS	11	Decreasing ¹	12	Decreasing ¹	12	Decreasing ¹	12	Decreasing ¹
MW-2-90	03/2008 - 10/2018	12	NS ³	12	NS	12	NS	12	NS	12	NS
MW-9-90R	03/2008 - 10/2018	12	Decreasing ¹	12	NS	12	Decreasing	12	NS	12	Decreasing ¹
MW-1-93	03/2008 - 10/2018	12	Decreasing	12	Decreasing ¹	12	Decreasing	12	Decreasing ¹	12	Decreasing ¹
MW-3-94	03/2008 - 10/2018	13	Decreasing	13	NS	13	NS	13	NS	13	Decreasing ¹
MW-1-81	06/2013 - 10/2018	10	Decreasing	10	NS	10	ND	10	NS ²	10	ND ¹
MW-4-94	06/2013 - 10/2018	10	NS ²	10	Decreasing	10	NS	10	Decreasing	10	Decreasing ¹
MW-7-90	06/2013 - 10/2018	11	Decreasing ¹	11	NS	11	NS	11	NS	11	NS
<i>Former Sludge Incorporation Area (SIA) Monitoring Wells</i>											
MW-1-79	03/2008 - 10/2018	13	Increasing	13	NS	13	Decreasing	13	Decreasing	13	Decreasing ¹
MW-3-79	03/2008 - 10/2018	12	NS	12	Decreasing	12	Decreasing	12	Decreasing	12	Decreasing ¹
MW-4-79	03/2008 - 10/2018	13	Decreasing	13	NS	13	Decreasing	13	Decreasing	13	Decreasing ¹
MW-5-79	03/2008 - 10/2018	13	Decreasing	13	ND	13	NS ⁴	13	Decreasing	13	ND
MW-3-81	03/2008 - 10/2018	13	Increasing	13	NS	13	Increasing	13	NS	13	Increasing
MW-7-94	03/2008 - 10/2018	13	NS	13	NS	13	Decreasing	13	Decreasing	13	NS
MW-8-94	03/2008 - 10/2018	12	Increasing	12	NS	12	NS	12	NS	11	NS
MW-9-94	03/2008 - 10/2018	12	NS	12	NS	12	Decreasing	12	NS	12	NS
<i>On-Site Reference Monitoring Wells</i>											
MW-2-81	03/2008 - 10/2018	12	NS	12	NS ²	12	ND	12	NS ²	12	ND
MW-4-81	03/2008 - 10/2018	12	NS	12	NS	12	Decreasing	12	Increasing	12	Decreasing ¹
MW-5-81	03/2008 - 10/2018	12	ND	12	ND	12	ND	12	NS	12	ND
<i>Site Production Wells</i>											
PW-11	08/2006 - 10/2018	17	Decreasing	16	ND	17	Decreasing	16	Decreasing	16	Decreasing
PW-112	11/2013 - 10/2018	13	Decreasing	13	NS	13	Decreasing	13	Decreasing	13	Decreasing
PW-113 ⁵	10/2014 - 10/2018	9	NS	9	NS	9	Decreasing	9	NS	9	Decreasing
PW-37	08/2006 - 10/2018	16	NS ³	15	NS ⁴	16	Decreasing	15	Decreasing ¹	15	NS
PW-91	06/2013 - 10/2018	14	ND	14	NS ⁴	14	ND	14	Decreasing ¹	14	ND
PW-94 ⁶	12/2009 - 10/2018	15	Increasing								



Table 4-6 (cont'd)

Mann-Kendall Trend Test Summary
PFOS, PFBS, PFOA, PFBA and PFHS
Groundwater Analytical Data
Cordova Site, Cordova IL

Well ID	Trend Analysis Data Range	PFOS		PFBS		PFOA		PFBA		PFHS	
		Number of Data Points	Trend	Number of Data Points	Trend						
<i>Residential Wells</i>											
23321 ⁷	07/2011 - 10/2017	6	NS	6	ND	6	ND	6	ND	6	ND
22610	07/2011 - 10/2018	8	NS	8	ND	8	ND	8	ND	8	ND
22704	07/2011 - 10/2018	8	ND	8	ND	8	ND	8	Increasing	8	ND
22703	07/2011 - 10/2018	7	NS	7	ND	7	ND	7	NS	7	ND
22414	07/2011 - 10/2018	7	ND	7	ND	7	ND	7	Increasing	7	ND
22009	07/2011 - 10/2018	6	ND	6	ND	6	ND	6	Decreasing ¹	6	ND
21421	07/2011 - 10/2018	8	ND	8	NS	8	ND	8	NS	8	ND

Notes:

Results are for the Mann-Kendall test for trend at a significance level of 0.05.

NS - No statistically significant trend identified.

ND - ≥ 75% of results are less than Laboratory Quantitation Limit (LQL) and at least the last four results are also less than the LQL.

¹ Previous trend was not statistically significant.

² Previous trend was decreasing.

³ Previous trend was increasing.

⁴ Previous trend was not detected.

⁵ Production well PW-13 was shut down in 2014 and replaced with PW-113 that went on-line in October 2014.

⁶ Former "Agricultural Well" #22580.

⁷ A water sample could not be collected from residential well 23321 in 2018.



Table 4-7

Summary of Groundwater PFAS Analytical Data - Residential Wells
July 2011-October 2018 Sampling Events
Cordova Site, Cordova, IL

WELL ID	Date Sampled	Average Sample Concentration (ng/ml, ppb)				
		PFBA	PFOA	PFBS	PFHS	PFOS
23321	Jul 2011	0.224	<0.0250	<0.0250	<0.0250	<0.0250
	Aug 2012	0.451	<0.0240	<0.0250	<0.0250	<0.0232
	Feb 2013	--	--	--	--	--
	Oct 2014	0.208	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2015	0.290	<0.0240	<0.0250	<0.0236	0.0279
	Oct 2016	0.181	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	0.507	<0.0240	<0.0250	<0.0250	<0.0232
22610	Jul 2011	0.182	<0.0250	<0.0250	<0.0250	<0.0250
	Aug 2012	0.105	<0.0240	<0.0250	<0.0250	<0.0232
	Feb 2013	0.157	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2014	0.367	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2015	1.38	<0.0240	<0.0250	<0.0236	0.031
	Oct 2016	0.390	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	0.430	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2018	0.388	<0.0240	<0.0500	<0.0250	<0.0232
22704	Jul 2011	0.452	<0.0250	<0.0250	<0.0250	0.041
	Aug 2012	0.739	<0.0240	<0.0250	<0.0250	<0.0232
	Feb 2013	1.01	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2014	1.03	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2015	1.52	<0.0240	<0.0250	<0.0236	<0.0232
	Oct 2016	1.02	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	1.24	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2018	1.69	<0.0240	<0.0500	<0.0250	<0.0232
22703	Jul 2011	0.078 ^[a]	<0.0250	<0.0250	<0.0250	<0.0250
	Aug 2012	--	--	--	--	--
	Feb 2013	0.070	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2014	0.973	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2015	0.164	<0.0240	<0.0250	<0.0236	0.0260
	Oct 2016	0.707	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	0.661	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2018	0.918	<0.0240	<0.0500	<0.0250	<0.0232
22414	Jul 2011	0.067 ^[a]	<0.0250	<0.0250	<0.0250	<0.0250
	Aug 2012	--	--	--	--	--
	Feb 2013	0.63	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2014	1.70	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2015	0.916	<0.0240	<0.0250	<0.0236	<0.0232
	Oct 2016	2.56	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	2.77	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2018	0.949	<0.0240	<0.0500	<0.0250	<0.0232



Table 4-7 (cont'd)

Summary of Groundwater PFAS Analytical Data - Residential Wells
July 2011-October 2018 Sampling Events
Cordova Site, Cordova, IL

WELL ID	Date Sampled	Average Sample Concentration (ng/ml, ppb)				
		PFBA	PFOA	PFBS	PFHS	PFOS
22009	Jul 2011	3.41	<0.0250	<0.0250	<0.0250	<0.0250
	Aug 2012	--	--	--	--	--
	Feb 2013	--	--	--	--	--
	Oct 2014	2.73	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2015	4.42	<0.0240	<0.0250	<0.0236	<0.0232
	Oct 2016	2.64	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	2.26	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2018	1.93	<0.0240	<0.0500	<0.0250	<0.0232
21421	Jul 2011	1.73	<0.0250	0.0583	<0.0250	<0.0250
	Aug 2012	2.16	<0.0240	0.0294	<0.0250	<0.0232
	Feb 2013	2.27	<0.0240	0.0364	<0.0250	<0.0232
	Oct 2014	3.04	<0.0240	0.0348	<0.0250	<0.0232
	Oct 2015	2.73	<0.0240	<0.0250	<0.0236	<0.0232
	Oct 2016	2.74	<0.0240	<0.0250	<0.0250	<0.0232
	Oct 2017	2.15	<0.0240	0.0313	<0.0250	<0.0232
	Oct 2018	2.06	<0.0240	<0.0500	<0.0250	<0.0232

Notes:

ng/ml - nanogram per milliliter.

ppb - parts per billion.

--- Sample could not be collected.

[a] - The relative percent difference (RPD) did not meet method acceptance criteria of $\leq 20\%$.

Concentrations reported are the average of primary and duplicate sample analytical results.



5. FINDINGS

The GMZ Groundwater Sampling Plan was developed to collect hydrogeologic and PFAS analytical data that could be used to assess long-term groundwater conditions in the area of the Site. Groundwater sampling events were performed at the Site in April and October 2018 that represent the eighth and ninth sampling rounds performed in accordance with the GMZ Groundwater Sampling Plan. The results of these sampling events are provided in this document.

The following sections contain a summary of the findings of the groundwater elevation data, and the monitoring well, production well and residential well PFAS results for groundwater samples collected in 2018 at the Site.

5.1 GROUNDWATER ELEVATION DATA

Groundwater elevation data were recorded in accessible Site monitoring wells and piezometers during the April and October 2018 sampling events. These groundwater elevation data were used to construct groundwater elevation contour maps to assess groundwater flow directions at the Site. Previous hydrogeologic investigations performed at the Site have shown that the direction of groundwater flow is predominately away from the Mississippi River to the east toward the Site production wells. This groundwater flow direction was confirmed by the groundwater elevation measurements recorded at the Site in April and October 2018. As such, effective capture of impacted groundwater at the Site continues to be maintained. The hydraulic gradient between the manufacturing area and Site production wells was calculated to be 0.0021 (ft/ft) and 0.0020 (ft/ft) in April and October 2018, respectively. Because of the relatively flat hydraulic gradient beneath the manufacturing area, the direction of groundwater flow in this area may be susceptible to temporary gradient changes during periods of higher recharge from rainfall or snow melt events.

5.2 MONITORING AND PRODUCTION WELL SAMPLING

In accordance with the GMZ Sampling Plan, groundwater samples were collected in April and October 2018 at 19 monitoring wells and 6 production wells. Pump mechanical issues



prevented groundwater samples from being collected in production well PW-24 in April and October 2018 (well has not been in operation since October 2014 and is scheduled to be replaced in 2019).

The following are some key findings of the monitoring well sampling results:

- PFBA concentrations were generally higher than other PFAS in each monitoring well sampled.
- The highest total PFAS concentrations detected in the manufacturing area were in the groundwater sample collected from monitoring well MW-3-94. Historically, the highest total PFAS concentrations in the manufacturing area have been detected in monitoring well MW-3-94 or nearby monitoring well MW-9-90R.
- The April and October 2018 PFAS concentrations in monitoring wells located along the northern and western perimeter of the manufacturing area (MW-2-90, MW-1-88, MW-1-93, MW-4-94 and MW-1-81) are generally lower compared to monitoring wells within the middle of the manufacturing area (MW-9-90R, MW-3-94 and MW-7-90). This distribution is consistent with historical PFAS analytical data.
- Mann-Kendall statistical analyses results primarily indicate either no statistically significant or a statistically significant decreasing trend in PFAS concentrations in groundwater samples collected from manufacturing and former SIA monitoring wells.
- The highest total PFAS concentrations detected in the former SIA were at monitoring well MW-1-79, which is consistent with historical PFAS analytical data. The measured PFAS concentrations in groundwater generally correlates with suspected PFAS source areas. Specifically, monitoring wells (e.g. MW-1-79 and MW-4-81) located hydraulically downgradient of the manufacturing area and former SIAs generally have higher PFAS concentrations than monitoring wells located along the upgradient perimeter of the manufacturing and former SIAs. The following are some key findings of the production well sampling results:



- PFAS concentrations are lower in the samples collected from production wells PW-11, PW-37 and PW-91 compared to the PFAS results for other production wells (PW-112, PW-113 and PW-94). The higher PFAS concentrations in production wells PW-112, PW-113 and PW-94 are not unexpected given that these wells are located essentially on the centerline of groundwater being drawn from the Site's manufacturing area (and significant portions of the former SIAs) into the cone of depression created by the production well field.
- The Mann-Kendall statistical analyses primarily indicate either no statistically significant or a statistically significant decreasing trend for the PFAS concentrations in the production wells. However, consistent with the past few years, a statistically significant increasing trend was identified for the PFAS at production well PW-94. It should be noted that this increase is most apparent in comparing 2008-early 2014 data against late 2014-2017 data; since April 2015, PFAS concentrations have shown a generally stable to declining trend. Production well PW-94 is located to the south of the former SIAs and was put on-line relatively recently (i.e. 2011) compared to the other production well locations. The increase in PFAS concentrations observed in production well PW-94 may relate to downtime and reconstruction activities in 2013 and 2014 for nearby production wells PW-12 and PW-13. It is also likely due to the continued pumping of this well since it was reactivated as a production well in 2011, and the pumping of nearby production well PW-91 (located to the east of production well PW-94). It appears that operation of production well PW-94 is helping to capture groundwater flowing easterly and/or southerly from the manufacturing area and/or from certain former SIAs.

5.3 RESIDENTIAL WELL SAMPLING

Groundwater samples were collected in October 2018 at six residential wells within a 0.5 mile radius of the Site. A water sample could not be collected from residential well 23321 in October 2018. The following are some key findings of the 2018 residential well sampling results:



- PFOA, PFBS, PFHS and PFOS were not detected in any of the residential well samples in the October 2018 sampling event.
- PFBA was detected in each of the residential wells sampled in 2018 with concentrations ranging from 0.388 ppb to 2.06 ppb, significantly below the Illinois EPA baseline groundwater remediation objective for PFBA of 20 ppb.
- The Mann-Kendall trend test results indicate a statistically significant decreasing trend in PFBA for residential well 22009. No statistically significant trend in PFBA concentrations for residential wells 22703, 21421 and 22610, while a statistically significant increasing trend was identified for residential wells 22704 and 22414. The PFBA analytical results for these wells are in the low ppb range and have fluctuated over a limited range in concentration. Furthermore, the 2018 PFBA results are comparable to 2017 PFBA concentrations at these two residential wells.
- In summary, the residential well groundwater samples have PFAS results that are either so low that they cannot be measured ("non detectable") or they are well below regulatory guidance values established to be protective for a lifetime of consumption.

5.4 NPDES WASTEWATER PERMIT MONITORING

The following observations are provided for the NPDES permit monitoring:

- Analytical results have been below limits of quantitation for PFUnA, PFDoA, PFTrA and PFOSA.
- In 2018, PFBA concentrations ranged from 84.9 to 2390 ng/mL. Other detected constituents were measured at concentrations less than 32 ng/mL.

5.5 SUMMARY

The additional environmental assessment data collected in 2018, and presented in this report, are consistent with the extensive datasets generated previously for the Site. More specifically, the following observations continue to be valid:



- Groundwater with PFAS concentrations greater than site-specific objectives has only been measured in on-site wells and this water is not used for drinking water purposes. Furthermore, this water is contained or “captured” by an existing network of production wells that supply process water for ongoing operations at the Site.
- PFAS measurements in off-site groundwater are dominated by results less than the laboratory quantitation limit and where quantifiable results are obtained, they are significantly less than the baseline groundwater remediation objectives developed by the Illinois EPA.
- Site hydrogeologic conditions are generally stable (i.e. flow direction and capture of on-site groundwater).

Accordingly, based on the extensive characterization of Site conditions that has been, and continues to be, conducted, and the fact that no exposure pathways of concern have been identified, the establishment of a GMZ as approved by Illinois EPA, is confirmed as an effective and appropriate remedial action.



6. FUTURE COURSE OF ACTION

The PFAS analytical data resulting from the monitoring of Site groundwater will continue to be used to evaluate PFAS concentration variations, ranges and trends for residential, monitoring and production wells. Ongoing communication will continue with Illinois EPA staff as appropriate and/or requested.

In accordance with the Illinois EPA-approved GMZ Groundwater Sampling Plan, the following activities will be performed in the approximate time-frames noted.

Groundwater Monitoring

- Semiannual groundwater sampling will be performed in April and October 2019.
- Annual residential well sampling will be performed in October 2019.
- Groundwater elevation data will be collected during each sampling round to evaluate the direction of groundwater flow across the Site.

Future Submittals to Illinois EPA:

- As requested by the Illinois EPA, an updated well search will be submitted in the second quarter of 2019.
- An annual groundwater monitoring report will be submitted to Illinois EPA in the first quarter of 2020 presenting a summary of the PFAS groundwater analytical data collected at the Site in 2019.



7. REFERENCES

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APPENDIX A
SUMMARY OF WELL CONSTRUCTION INFORMATION

Summary of Well Information
3M Cordova Site, Cordova, IL

Well ID	Nothing (UTM NAD83 Zone 15 Meter)	Easting (UTM NAD83 Zone 15 Meter)	Completion Date	Casing Material (SS/CS/PPVC)	Screen Material	Approximate Total Well Depth (ft btoc)	TOC Elevation (ft MSL)	Approximate Depth to Top of Screen (ft bgs)	Approximate Depth to Bottom of Screen (ft bgs)	Well Diameter (in.)
MW-1-79	4625463.4	726471.3	May-79	CS	SS	77.7	626.71	72	75	5
MW-3-79	4625743.1	726306.4	May-79	CS	SS	77.4	633.04	72	75	5
MW-4-79	4625922.2	726619.6	May-79	CS	SS	85.3	626.42	87	90	5
MW-5-79	4626118.1	726896.2	May-79	CS	SS	81.6	623.91	77	80	5
MW-1-81	4626297.9	725415.1	Nov-81	CS	SS	60.5	592.42	54	57	5
MW-2-81	4625250.8	725255.7	Nov-81	CS	SS	44.6	601.2	42	45	5
MW-3-81	4625434.6	725061.1	Nov-81	CS	SS	36.1	591.25	35	38	5
MW-4-81	4625601.9	725833.6	Nov-81	CS	SS	65.7	611.58	66	69	5
MW-5-81	4626546.0	727017.2	Nov-81	CS	SS	64.0	601.54	62	65	5
MW-1-88	4626278.1	725283.7	Dec-88	SS	SS	32.3	595.23	20	30	2
MW-2-90	4625989.4	725053.9	Jan-90	SS	SS	32.6	596.59	19.5	29.5	2
MW-3-90	4626090.0	725256.4	Jan-90	SS	SS	27.6	591.78	15	25	2
MW-4-90	4626334.1	725587.3	Jan-90	SS	SS	30.1	593.61	17	27	2
MW-5-90	4625434.6	725061.1	Feb-90	SS	SS	27.4	591.31	14.5	24.5	2
MW-6-90	4625922.2	726618.5	Feb-90	SS	SS	72.6	627.48	54.5	70.5	2
MW-7-90	4626147.9	725337.2	Feb-90	SS	SS	31.6	596.29	20.5	30.5	2
MW-8-90	4626204.0	725351.4	Feb-90	SS	SS	32.5	595.45	20	30	2
MW-9-90R	4626019.8	725214.1	Oct-91	SS	SS	27.7	594.68	17	27	2
MW-1-91	4626168.1	725311.6	Aug-91	SS	SS	25.2	591.65	13	23	2
MW-2-91R	4626142.9	725300.4	Feb-93	SS	SS	25.0	592.52	11.5	24	2
MW-1-93	4626407.6	725433.7	Aug-93	PVC	PVC	24.2	593.93	12.5	22.5	2
MW-2-93	4626355.7	725465.2	Aug-93	PVC	PVC	23.9	594.21	11.8	21.8	2
MW-3-93	4626366.3	725492.2	Aug-93	PVC	PVC	24.9	594.41	12	22	2
MW-1-94	4625742.9	726305.4	Jan-94	SS	SS	72.6	632.68	54.5	71	2
MW-2-94	4625601.3	725836.6	Jan-94	SS	SS	47.6	612.21	34.5	44.5	2
MW-3-94	4625952.5	725337.1	Jan-94	SS	SS	31.3	595.53	18.5	28.5	2
MW-4-94	4626146.0	725463.2	Jan-94	SS	SS	32.6	597.95	19	29	2
MW-5-94	4626189.4	725278.6	Jan-94	SS	SS	24.6	592.51	10	19	2
MW-6-94	4626158.7	725261.4	Jan-94	SS	SS	22.6	590.27	10	20	2
MW-7-94	4625890.8	725797.7	Jun-94	SS	SS	32.6	597.98	20	30	2
MW-8-94	4626132.7	725782.8	Jun-94	SS	SS	30.1	595.57	17.5	28	2
MW-9-94	4626379.2	725770.7	Jun-94	SS	SS	32.6	597.76	19.5	30.5	2
MW-10-94	4626411.2	727071.9	Jun-94	SS	SS	45.1	602.15	27	43	2

Summary of Well Information (cont'd)
3M Cordova Site, Cordova, IL

Well ID	Northing (UTM NAD83 Zone 15 Meter)	Easting (UTM NAD83 Zone 15 Meter)	Well Completion Date	Casing Material (SS/CS/PVC)	Screen Material	Approximate Total Well Depth (ft btoc)	TOC Elevation (ft MSL)	Approximate Depth to Top of Screen (ft bgs)	Approximate Depth to Bottom of Screen (ft bgs)	Well Diameter (in.)
MW-1-98	4626027.0	725275.0	Mar-98	--	--	--	595.74	14	28	2
MW-2-98	4626026.3	725265.0	Mar-98	--	--	31.6	595.62	14	29	2
PZ-01-13	4626398.2	727220.9	Apr-13	PVC	PVC	56.3	599.27	47	57	2
PZ-02-13	4626099.2	727125.9	May-13	PVC	PVC	87.0	625.44	76	86	2
PZ-03-13	4625901.2	727123.9	May-13	PVC	PVC	89.8	626.54	80	90	2
PZ-04-13	4625722.2	727103.9	May-13	PVC	PVC	90.7	626.24	80	90	2
PZ-05-13	4625329.2	726758.9	May-13	PVC	PVC	93.5	627.05	83.5	93.5	2
PZ-06-13	4625259.2	727147.9	May-13	PVC	PVC	90.6	629.19	80	90	2
MW-11-N	4625616.3	727248.1	--	--	--	180.0	628.95	--	--	4
PW-11	4625494.2	727249.5	Apr-69	CS	SS	179.0	--	149	179	20
PW-12	46253736.1	727244.5	Mar-69	CS	SS	168.0	--	138	168	20
PW-13	4625474.5	726996.5	Feb-69	CS	SS	177.0	--	147	177	20
PW-24	4625984.9	727241.8	Jan-74	CS	SS	170.0	--	136	167	20
PW-37	4626219.4	727244.1	Dec-86	CS	SS	175.0	--	145	175	20,16
PW-91	4625032.6	727171.3	May-12	CS	SS	183.0	--	130	183	24
PW-94	4625172.8	726559.7	Apr-92	CS	SS	117.0	--	97	117	14,12
PW-112	4625744.5	727231.6	Oct-12	CS	SS	178.0	--	128	178	24
PW-113	4625483.3	727025.1	2014	--	--	--	--	--	--	--

-- = information not available

CS = Carbon Steel

SS = Stainless Steel

PVC = Polyvinyl Chloride

ft btoc = feet below top of casing

ft MSL = feet above mean sea level

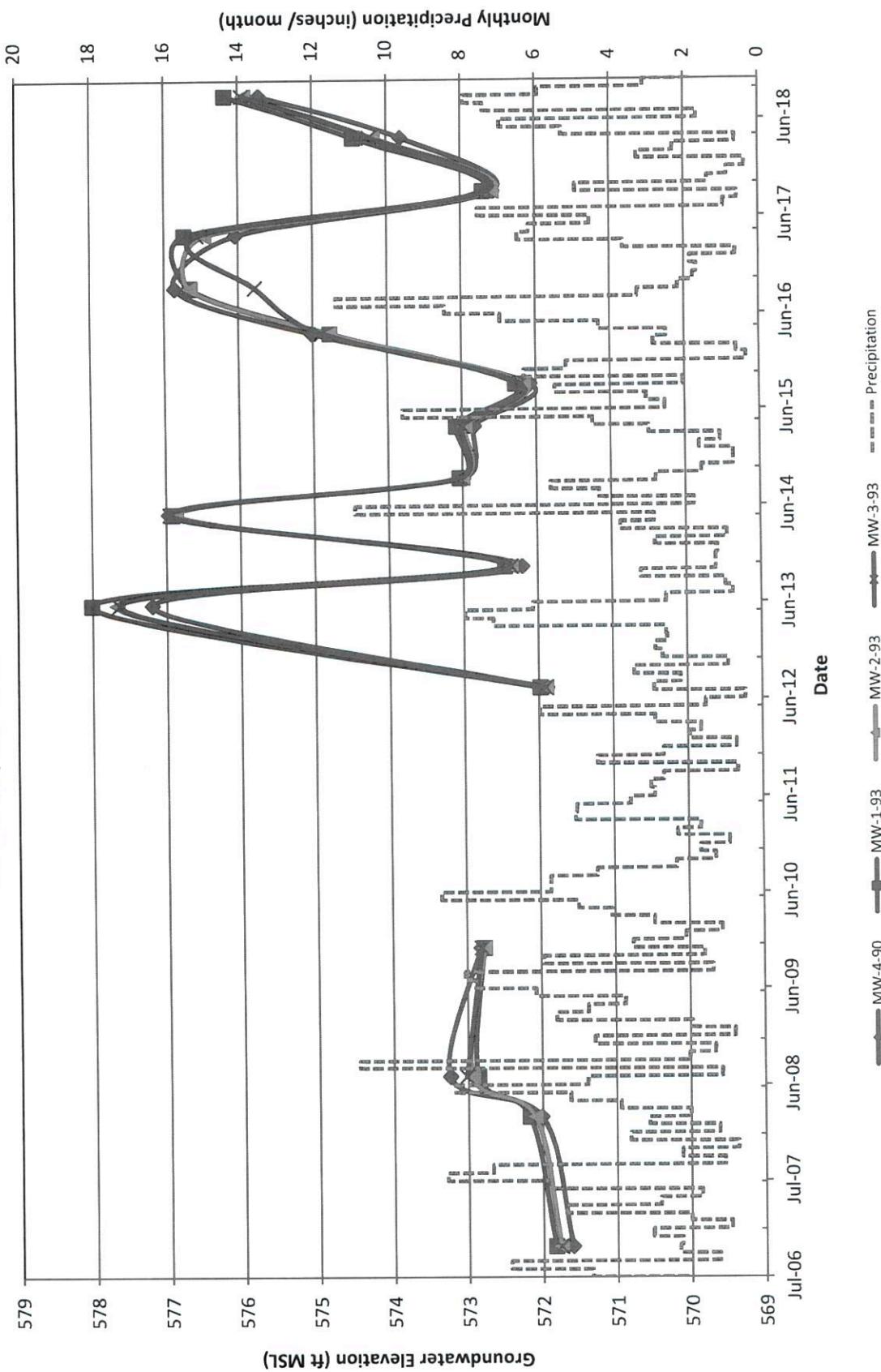
ft bgs = feet below ground surface



APPENDIX B
GROUNDWATER HYDROGRAPHS

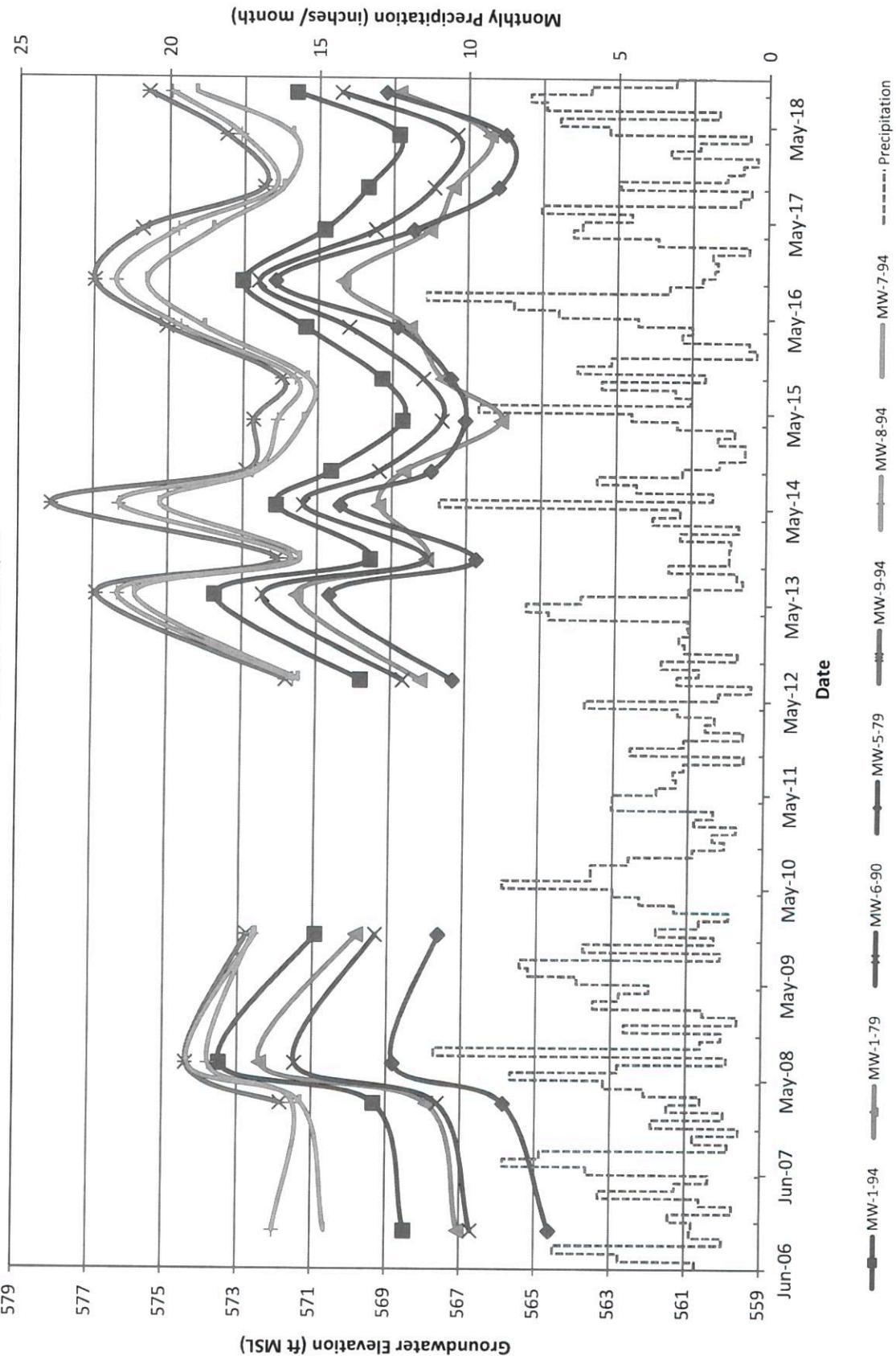


Groundwater Hydrograph
Manufacturing Area
Monitoring Wells MW-4-90, MW-1-93, MW-2-93 and MW-3-93
October 2006 - October 2018
Cordova Site, Cordova, IL



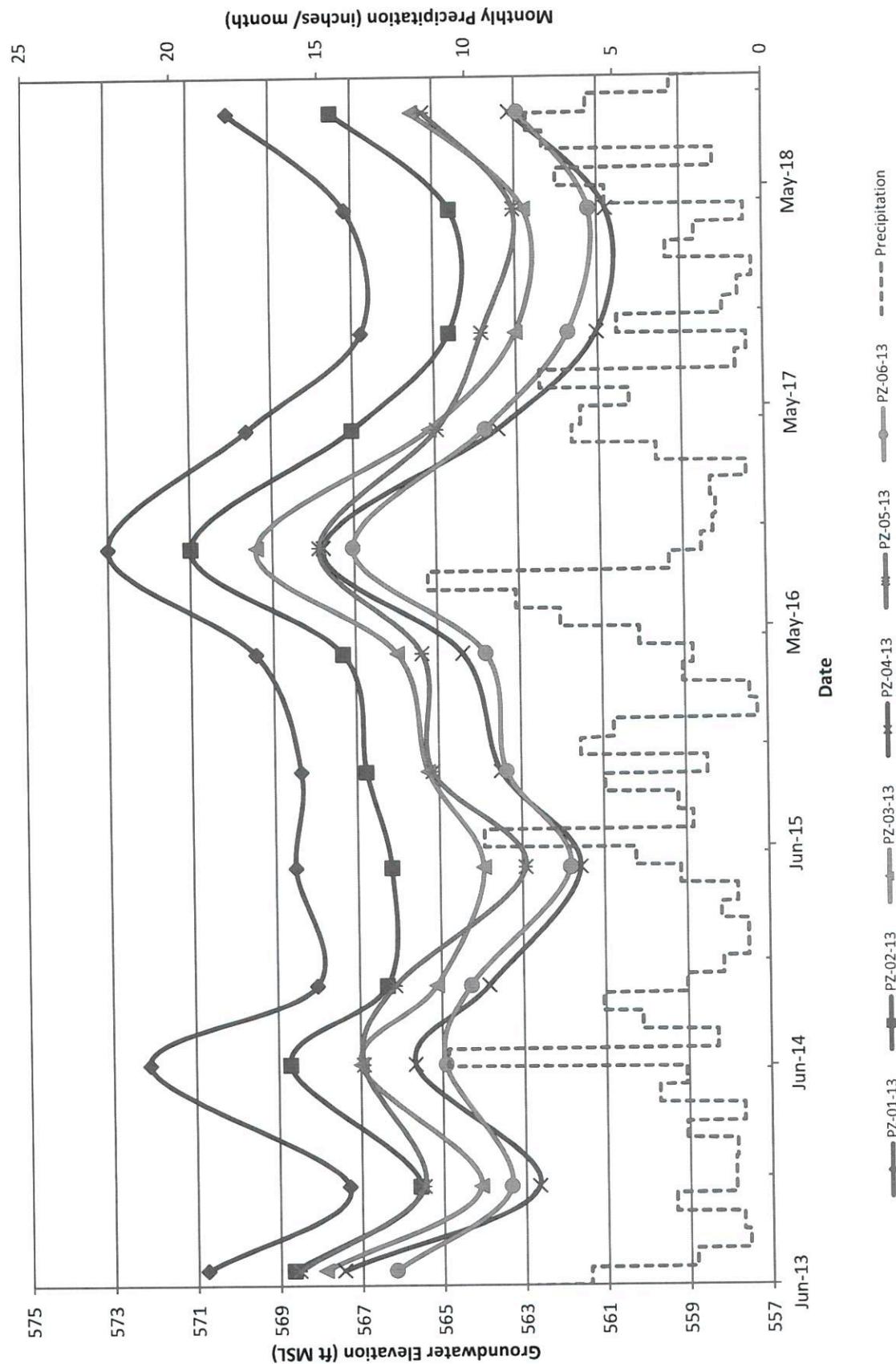


Groundwater Hydrograph
Former Sludge Incorporation Zone
Monitoring Wells MW-1-94, MW-1-79, MW-6-90, MW-5-79, MW-7-94, MW-8-94 and MW-9-94
October 2006 - October 2018
Cordova Site, Cordova, IL





Groundwater Hydrograph
Piezometers PZ-01-13,PZ-02-13,PZ-03-13,PZ-04-13,PZ-05-13 and PZ-06-13
June 2013 - October 2018
Cordova Site, Cordova, IL



2018-10-COIL-GW-Elev-DTV-DC-rev.xlsxPZ-CHT(A01)



APPENDIX C

LABORATORY ANALYTICAL DATA

- **April 2018 Laboratory Analytical Data**
- **October 2018 Laboratory Analytical Data**



- April 2018 Laboratory Analytical Data

Final Report

Analysis of PFBA, PFOA, PFBS, PFHS, and PFOS 3M Cordova Groundwater Wells

April 2018 Sampling

Laboratory Request Number: ISO18-16-01

Report Date – Date of Last Signature

Testing Laboratory

3M Environment, Health and Safety
3M EHS Laboratory
Building 260-5N-17
Maplewood, MN 55144-1000

Requester

Karie Blomquist
3M Building 224-5W-17
Saint Paul, MN 55144-1000
Phone: (651) 737-3477



The testing reported herein meet the requirements of ANSI/ISO/IEC 17025:2005 "General Requirements for the Competence of Testing and Calibration Laboratories", in accordance with A2LA Certificate # 2052.01. Additionally, the laboratory's quality system has been audited and was determined to be in conformance with the EPA GLPs (40 CFR 792) by an independent A2LA assessment.

3M EHS Laboratory

3M EHS Laboratory Manager: Brian T. Mader, Ph.D.
3M Principal Analytical Investigator and Report Author: Susan Wolf

Analytical Report ISO18-16-01

Analysis of PFBA, PFOA, PFBS, PFHS, and PFOS
3M Cordova Groundwater Wells
April 2018 Sampling

Report Date: Date of Last Signature

1 Introduction/Summary

The 3M Environmental, Health and Safety (EHS) Laboratory prepared and analyzed groundwater samples collected by Weston Solutions personnel at the 3M Cordova facility. Samples were collected April 23-25, 2018. Samples were returned to the 3M EHS Laboratory on April 27 2018, on ice for the analysis of Perfluorobutanoic acid (PFBA), Perfluorooctanoic acid (PFOA), Perfluorobutane sulfonate (PFBS), Perfluorohexane sulfonate (PFHS) and Perfluorooctane sulfonate (PFOS) under laboratory project number ISO18-16-01.

The 3M EHS Laboratory prepared sample containers for twenty-six sampling locations. Location PW24 was not sampled. Each empty container was marked with a "fill to here" line that corresponded to a final volume of 200 mL. Containers reserved for field matrix spikes were fortified with an appropriate matrix spike solution containing the target analytes prior to being sent to the field for sample collection. Select sample bottles were fortified with internal standards and surrogate recovery standards prior to being sent to the field for sample collection.

Samples were prepared and analyzed for PFBA, PFOA, PFBS, PFHS, and PFOS using method ETS-8-044.3 "Method of Analysis for the Determination of Perfluorinated Compounds in Water by LC/MS/MS; Direct Injection Analysis". Internal standards were used to aid in the data quality objectives for the analysis of select samples, where applicable.

Table 1 summarizes the sample results using the analytical method identified above. All results for quality control samples prepared and analyzed with the samples will be reported and discussed elsewhere in this report.



The testing reported herein meet the requirements of ANSI/ISO/IEC 17025:2005 "General Requirements for the Competence of Testing and Calibration Laboratories", in accordance with A2LA Certificate # 2052.01. Additionally, the laboratory's quality system has been audited and was determined to be in conformance with the EPA GLPs (40 CFR 792) by an independent A2LA assessment.

Table 1. Sample Results Summary⁽¹⁾

3M LIMS ID	Sample Description	PFBA Concentration (ng/mL)	PFOA Concentration (ng/mL)	PFBS Concentration (ng/mL)	PFHS Concentration (ng/mL)	PFOS Concentration (ng/mL)
Monitoring Wells (MW)						
ISO18-16-01-001	COIL-GW-MW-1-79-0-180425	90.4	2.58	7.88	4.02	41.2
ISO18-16-01-001-DUP	COIL-GW-MW-1-79-DB-180425	90.2	2.42	7.82	4.00	39.0
		Average	90.3	2.50	7.85	4.01
		%RPD Sample/Sample Dup	0.22	6.4	0.76	5.5
ISO18-16-01-002	COIL-GW-MW-3-79-0-180423	15.5	0.426	0.198	0.894	11.0
ISO18-16-01-002-DUP	COIL-GW-MW-3-79-DB-180423	13.7	0.378	0.171	0.770	9.42
		Average	14.6	0.402	0.185	0.832
		%RPD Sample/Sample Dup	12	12	15	15
ISO18-16-01-003	COIL-GW-MW-4-79-0-180423	0.568	<0.0240	<0.0250	<0.0250	0.0340
ISO18-16-01-003-DUP	COIL-GW-MW-4-79-DB-180423	0.574	<0.0240	<0.0250	<0.0250	<0.0232
		Average	0.571	<0.0240	<0.0250	<0.0250
		%RPD Sample/Sample Dup	1.1	NA	NA	NA
ISO18-16-01-004	COIL-GW-MW-5-79-0-180423	0.111	<0.0240	<0.0250	<0.0250	0.0294
ISO18-16-01-004-DUP	COIL-GW-MW-5-79-DB-180423	0.110	<0.0240	<0.0250	<0.0250	0.0244
		Average	0.111	<0.0240	<0.0250	<0.0250
		%RPD Sample/Sample Dup	0.90	NA	NA	NA
ISO18-16-01-005	COIL-GW-MW-1-81-0-180423	0.0868	<0.0240	<0.0250	<0.0250	0.0256
ISO18-16-01-005-DUP	COIL-GW-MW-1-81-DB-180423	0.0770	<0.0240	<0.0250	<0.0250	0.0258
		Average	0.0819	<0.0240	<0.0250	<0.0250
		%RPD Sample/Sample Dup	12	NA	NA	NA
ISO18-16-01-006	COIL-GW-MW-3-81-0-180423	47.4	6.66	0.290	12.9	42.2
ISO18-16-01-006-DUP	COIL-GW-MW-3-81-DB-180423	47.6	6.60	0.290	12.8	42.6
		Average	47.5	6.63	0.290	12.9
		%RPD Sample/Sample Dup	0.42	0.90	0.00	0.78
ISO18-16-01-007	COIL-GW-MW-1-88-0-180424	3.62	<0.0240	<0.0250	<0.0250	0.468
ISO18-16-01-007-DUP	COIL-GW-MW-1-88-DB-180424	3.66	<0.0240	<0.0250	<0.0250	0.436
		Average	3.64	<0.0240	<0.0250	<0.0250
		%RPD Sample/Sample Dup	1.1	NA	NA	NA
ISO18-16-01-008	COIL-GW-MW-2-90-0-180424	4.24	0.0976	0.104	0.100	1.51
ISO18-16-01-008-DUP	COIL-GW-MW-2-90-DB-180424	4.32	0.0964	0.103	0.105	1.54
		Average	4.28	0.0970	0.104	0.103
		%RPD Sample/Sample Dup	1.9	1.2	0.97	4.9
ISO18-16-01-009	COIL-GW-MW-7-90-0-180424	39.2	0.840	1.01	2.64	19.7
ISO18-16-01-009-DUP	COIL-GW-MW-7-90-DB-180424	39.0	0.842	1.01	2.62	19.5
		Average	39.1	0.841	1.01	2.63
		%RPD Sample/Sample Dup	0.51	0.24	0.00	0.76
						1.0

NA = Not Applicable

- (1) Sample set was analyzed by internal standard calibration, except where noted. The analytical data uncertainties associated with the reported results by internal standard calibration are as follows: PFBA ± 22%, PFOA ± 9.2%, PFBS ± 13%, PFHS ± 13% and PFOS ± 9.9%.
- (2) Sample set was analyzed by external standard calibration. The analytical data uncertainties associated with the reported results by external standard calibration is as follows: PFBA ± 18%.
- (3) Trace levels of PFBA were detected in the rinseate blank. See section 4 of the report for additional information.

Table 1 continued. Sample Results Summary⁽¹⁾

3M LIMS ID	Sample Description	PFBA Concentration (ng/mL)	PFOA Concentration (ng/mL)	PFBS Concentration (ng/mL)	PFHS Concentration (ng/mL)	PFOS Concentration (ng/mL)
Monitoring Wells (MW)						
ISO18-16-01-010	COIL-GW-MW-9-90R-0-180424	98.6	0.462	3.94	0.748	13.5
ISO18-16-01-010-DUP	COIL-GW-MW-9-90R-DB-180424	104	0.488	4.08	0.782	14.8
		Average	101	0.475	4.01	0.765
		%RPD Sample/Sample Dup	5.3	5.5	3.5	4.4
ISO18-16-01-011	COIL-GW-MW-1-93-0-180424	4.06	0.0536	0.0892	0.266	0.936
ISO18-16-01-011-DUP	COIL-GW-MW-1-93-DB-180424	4.10	0.0504	0.0980	0.274	0.938
		Average	4.08	0.0520	0.0936	0.270
		%RPD Sample/Sample Dup	0.98	6.2	9.4	3.0
ISO18-16-01-012	COIL-GW-MW-3-94-0-180424	104	0.878	37.8	0.766	9.98
ISO18-16-01-012-DUP	COIL-GW-MW-3-94-DB-180424	104	0.920	38.8	0.764	10.4
		Average	104	0.899	38.3	0.765
		%RPD Sample/Sample Dup	0.0	4.7	2.6	0.26
ISO18-16-01-013	COIL-GW-MW-4-94-0-180424	30.2	1.26	2.20	2.32	12.7
ISO18-16-01-013-DUP	COIL-GW-MW-4-94-DB-180424	29.4	1.21	2.18	2.26	12.7
		Average	29.8	1.24	2.19	2.29
		%RPD Sample/Sample Dup	2.7	4.0	0.91	2.6
ISO18-16-01-014	COIL-GW-MW-7-94-0-180424	28.8	0.972	2.96	3.28	8.36
ISO18-16-01-014-DUP	COIL-GW-MW-7-94-DB-180424	27.4	0.962	2.76	3.16	8.50
		Average	28.1	0.967	2.86	3.22
		%RPD Sample/Sample Dup	5.0	1.0	7.0	3.7
ISO18-16-01-015	COIL-GW-MW-8-94-0-180423	17.7	0.336	0.264	0.866	6.46
ISO18-16-01-015-DUP	COIL-GW-MW-8-94-DB-180423	17.7	0.312	0.262	0.834	6.20
		Average	17.7	0.324	0.263	0.850
		%RPD Sample/Sample Dup	0.00	7.4	0.76	3.8
ISO18-16-01-016	COIL-GW-MW-9-94-0-180423	16.9	0.470	0.155	1.48	7.94
ISO18-16-01-016-DUP	COIL-GW-MW-9-94-DB-180423	17.8	0.476	0.161	1.50	8.02
		Average	17.4	0.473	0.158	1.49
		%RPD Sample/Sample Dup	5.2	1.3	3.8	1.3
ISO18-16-01-017	COIL-GW-MW-2-81-0-180423	1.44	<0.0240	0.0898	<0.0250	0.0690
ISO18-16-01-017-DUP	COIL-GW-MW-2-81-DB-180423	1.31	<0.0240	0.0874	<0.0250	0.0664
		Average	1.38	<0.0240	0.0886	<0.0250
		%RPD Sample/Sample Dup	9.5	NA	2.7	NA
ISO18-16-01-018	COIL-GW-MW-4-81-0-180424	259	2.98	7.20	5.94	25.8
ISO18-16-01-018-DUP	COIL-GW-MW-4-81-DB-180424	246	2.90	7.12	5.90	24.8
		Average	253 ⁽²⁾	2.94	7.16	5.92
		%RPD Sample/Sample Dup	5.1	2.7	1.1	0.68

NA = Not Applicable

- (1) Sample set was analyzed by internal standard calibration, except where noted. The analytical data uncertainties associated with the reported results by internal standard calibration are as follows: PFBA ± 22%, PFOA ± 9.2%, PFBS ± 13%, PFHS ± 13% and PFOS ± 9.9%.
- (2) Sample set was analyzed by external standard calibration. The analytical data uncertainties associated with the reported results by external standard calibration is as follows: PFBA ± 18%.
- (3) Trace levels of PFBA were detected in the rinseate blank. See section 4 of the report for additional information.

Table 1 continued. Sample Results Summary⁽¹⁾

3M LIMS ID	Sample Description	PFBA Concentration (ng/mL)	PFOA Concentration (ng/mL)	PFBS Concentration (ng/mL)	PFHS Concentration (ng/mL)	PFOS Concentration (ng/mL)
Monitoring Wells (MW)						
ISO18-16-01-019	COIL-GW-MW-5-81-0-180423	0.165	<0.0240	<0.0250	<0.0250	<0.0232
ISO18-16-01-019-DUP	COIL-GW-MW-5-81-DB-180423	0.161	<0.0240	<0.0250	<0.0250	<0.0232
Average		0.163	<0.0240	<0.0250	<0.0250	<0.0232
%RPD Sample/Sample Dup		2.5	NA	NA	NA	NA
Production Wells (PW)						
ISO18-16-01-020	COIL-GW-PW-11-0-180425	1.08	<0.0240	<0.0250	<0.0250	<0.0232
ISO18-16-01-020-DUP	COIL-GW-PW-11-DB-180425	1.03	<0.0240	<0.0250	<0.0250	<0.0232
Average		1.06	<0.0240	<0.0250	<0.0250	<0.0232
%RPD Sample/Sample Dup		4.7	NA	NA	NA	NA
ISO18-16-01-021	COIL-GW-PW-112-0-180425	0.830	0.0946	<0.0250	0.156	2.20
ISO18-16-01-021-DUP	COIL-GW-PW-112-DB-180425	0.780	0.0894	<0.0250	0.150	1.94
Average		0.805	0.0920	<0.0250	0.153	2.07
%RPD Sample/Sample Dup		6.2	5.7	NA	3.9	13
ISO18-16-01-022	COIL-GW-PW-113-0-180425	28.0	1.35	4.46	2.04	28.4
ISO18-16-01-022-DUP	COIL-GW-PW-113-DB-180425	28.8	1.42	4.38	2.08	29.8
Average		28.4	1.39	4.42	2.06	29.1
%RPD Sample/Sample Dup		2.8	5.1	1.8	1.9	4.8
ISO18-16-01-023	COIL-GW-PW-37-0-180425	0.812	0.0912	<0.0250	0.144	1.87
ISO18-16-01-023-DUP	COIL-GW-PW-37-DB-180425	0.764	0.0818	<0.0250	0.148	1.89
Average		0.788	0.0865	<0.0250	0.146	1.88
%RPD Sample/Sample Dup		6.1	11	NA	2.7	1.1
ISO18-16-01-024	COIL-GW-PW-91-0-180425	1.46	<0.0240	<0.0250	<0.0250	<0.0232
ISO18-16-01-024-DUP	COIL-GW-PW-91-DB-180425	1.48	<0.0240	<0.0250	<0.0250	<0.0232
Average		1.47	<0.0240	<0.0250	<0.0250	<0.0232
%RPD Sample/Sample Dup		1.4	NA	NA	NA	NA
ISO18-16-01-025	COIL-GW-PW-94-0-180425	17.9	1.53	0.264	3.10	29.2
ISO18-16-01-025-DUP	COIL-GW-PW-94-DB-180425	16.7	1.46	0.238	2.82	25.8
Average		17.3	1.50	0.251	2.96	27.5
%RPD Sample/Sample Dup		6.9	4.7	10	9.5	12
ISO18-16-01-026	COIL-GW-Bldg 1 Coffee Sink-0-180425	7.44	0.390	0.950	0.606	7.72
ISO18-16-01-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB-180425	7.28	0.368	0.956	0.588	7.48
Average		7.36	0.379	0.953	0.597	7.60
%RPD Sample/Sample Dup		2.2	5.8	0.63	3.0	3.2
ISO18-16-01-027	COIL-GW-TRIP-0-180419	<0.0500	<0.0240	<0.0250	<0.0250	<0.0232
ISO18-16-01-028	COIL-GW-MW-3-79-RB01-0-180423	<0.0500	<0.0240	<0.0250	<0.0250	<0.0232
ISO18-16-01-029	COIL-GW-MW-4-94-RB02-0-180424	0.0598 ⁽³⁾	<0.0240	<0.0250	<0.0250	<0.0232

NA = Not Applicable

- (1) Sample set was analyzed by internal standard calibration, except where noted. The analytical data uncertainties associated with the reported results by internal standard calibration are as follows: PFBA ± 22%, PFOA ± 9.2%, PFBS ± 13%, PFHS ± 13% and PFOS ± 9.9%.
- (2) Sample set was analyzed by external standard calibration. The analytical data uncertainties associated with the reported results by external standard calibration is as follows: PFBA ± 18%.
- (3) Trace levels of PFOS were detected in the rinseate blank. See section 4 of the report for additional information.

2 Methods - Analytical and Preparatory

2.1 Methods

Analysis was completed following 3M EHS Laboratory method ETS-8-044.3 "Method of Analysis for the Determination of Perfluorinated Compounds in Water by LC/MS/MS; Direct Injection Analysis".

Table 2. Target Analytes

Target Analytes	Acronym	Reference Material Structure
Perfluorobutanoic Acid (C4 Acid)	PFBA	Linear
Perfluoroctanoic Acid (C8 Acid)	PFOA	Linear + Branched
Perfluorobutanesulfonate (C4 Sulfonate)	PFBS	Linear
Perfluorohexanesulfonate (C6 Sulfonate)	PFHS	Linear
Perfluorooctanesulfonate (C8 Sulfonate)	PFOS	Linear + Branched

2.2 Sample Collection

Samples were collected April 23 - 25, 2018 in Nalgene™ (high-density polyethylene) bottles prepared at the 3M EHS Laboratory. Prior to sample collection, bottles designated for field matrix spikes were spiked in the laboratory with a known volume of an appropriate matrix spiking solution containing the analytes of interest. Collected sample bottles were returned to the laboratory on ice on April 27, 2018.

2.3 Sample Preparation

Samples analyzed by internal standard calibration were prepared by removing a 0.4 mL aliquot of the well mixed sample and diluting it with 0.4 mL of methanol (dilution factor of 2). During the preparation of the laboratory control samples, an aliquot of a separate internal standard spiking solution was added to the laboratory control samples (nominal concentration of 1 ng/mL). The sample bottles were spiked with an internal standard mix at a nominal concentration of 1 ng/mL prior to being sent to the field for sample collection. The laboratory control samples were then diluted in the same manner as the samples.

Sample set COIL-GW-MW-4-81 (ISO18-16-01-018) was analyzed for PFBA by external standard calibration, requiring further dilution prior to analysis. Samples were prepared by diluting 1.0 mL of well-mixed sample with 9.0 mL of methanol (dilution factor of 10). A 200 ng/mL laboratory matrix spike was also prepared on the primary sample.

2.4 Analysis

All samples and quality control samples were analyzed for five target analytes using high performance liquid chromatography/tandem mass spectrometry (HPLC/MS/MS). Pertinent instrument parameters, the liquid chromatography gradient program, and the specific mass transitions analyzed are described in the tables below.

Due to the nature of the sample, the wide range of concentrations found in the sample, and the environmental occurrence of multiple isomers of the laboratory's analytes of interest, the software used for processing the analytical results is not able to consistently integrate the analytical peak, manual integration of the analytical peak is necessary. All manual integrations are performed following the procedures outlined in method ETS-12-010.2. The consistency of the laboratory's integration is ensured through the training of laboratory personnel, the peer review process required for all manual integrations, the review of manual integrations by the QAU, and where necessary the review of manual integrations by laboratory management.

Table 3. Instrument Parameters.

Instrument Name	ETS Kirk
Liquid Chromatograph	Agilent 1260
Analysis Method	ETS-8-044.3
Analysis Date	5/17/18 (Internal calibration) 5/24/18 (External calibration)
Guard column	Prism RP (2.1 mm X 50 mm), 5 μ
Analytical column	Betasil C18 (2.1 mm X 100 mm), 5 μ
Injection Volume	5 μ L
Mass Spectrometer	AB Sciex Triple Quad 5500
Ion Source	Turbo Spray
Polarity	Negative
Software	Analyst 1.6.3

Table 4. Liquid Chromatography Gradient Program.

Step Number	Total Time (min)	Flow Rate (μ L/min)	Percent A (2 mM ammonium acetate)	Percent B (Methanol)
ETS-8-044.3				
0	0.00	300	90.0	10.0
1	0.50	300	90.0	10.0
2	0.70	300	60.0	40.0
3	9.00	300	5.0	95.0
4	11.0	300	5.0	95.0
5	12.0	300	90.0	10.0
6	14.0	300	90.0	10.0

Table 5. Liquid Chromatography Gradient Program.

Analyte	Mass Transition Q1/Q3	Internal Standard	Mass Transition Q1/Q3
PFBA	213/169	$[^{13}\text{C}_4]\text{-PFBA}$ (1)	217/172
	413/369		
	413/219		421/376
	413/169		
PFBS	299/80	$[^{18}\text{O}_2]\text{-PFBS}$	
	299/99		303/84
PFHS	399/99	$[^{13}\text{C}_3]\text{-PFHS}$	
	399/80		402/80
PFOS	499/99	$[^{13}\text{C}_8]\text{-PFOS}$	
	499/80		507/80
	499/130		
$[^{13}\text{C}_3]\text{-PFBA}$	216/172	$[^{13}\text{C}_4]\text{-PFBA}$	217/172
$[^{13}\text{C}_4]\text{-PFOA}$	417/372	$[^{13}\text{C}_8]\text{-PFOA}$	421/376
$[^{13}\text{C}_4]\text{-PFOS}$	503/80	$[^{13}\text{C}_8]\text{-PFOS}$	507/80
The individual transitions were summed to produce a "total ion chromatogram" (TIC), which was used for quantitation.			
(1) Internal standard was not used for sample set COIL-GW-MW-4-81 analyzed on 5/24/18 by solvent dilution using external standard calibration.			

3 Data Analysis

3.1 Calibration

Solvent dilution analysis using internal standard calibration: Samples were analyzed against a matrix-matched stable isotope internal standard calibration curve. Calibration standards were prepared by spiking known amounts of stock solutions into 50 mL of 50:50 methanol:laboratory reagent water. The calibration standards contained an internal standard mix at a nominal concentration of 0.5 ng/mL. Calibration standards ranging from 0.0125 ng/mL to 100 ng/mL (nominal) were analyzed. The standards also contained the surrogates at concentrations ranging from 0.0125 ng/mL to 10 ng/mL (nominal). A quadratic, 1/x weighted, calibration curve of the ratio of the standard peak area counts over the internal standard peak area counts was used to fit the data for each analyte. The data were not forced through zero during the fitting process. Calculating the standard concentrations using the peak area ratios and the resultant calibration curve confirmed accuracy of each curve point.

Solvent dilution analysis using external standard calibration: Samples were analyzed against an external standard calibration curve. Calibration standards were prepared by spiking known amounts of the stock solution into 50 mL of 90:10 methanol: laboratory Milli-Q™ water. Calibration standards ranging from 0.25 ng/mL to 50 ng/mL (nominal) were analyzed. A quadratic, 1/x weighted, calibration curve of the standard peak area counts was used to fit the data for each analyte. Low or high points were disabled to meet method criteria. The data were not forced through zero during the fitting process. Calculating the standard concentrations using the peak area counts and the resultant calibration curve confirmed accuracy of each curve point.

For both methods of analysis, each curve point was quantitated using the overall calibration curve and reviewed for accuracy. Method calibration accuracy requirements of 100±25% (100±30% for the lowest curve point) were met for all analytes. The correlation coefficient (*r*) was greater than 0.998 for all analytes.

3.2 System Suitability

A calibration standard was analyzed four times at the beginning of the analytical sequence to demonstrate overall system suitability. The acceptance criteria for system suitability samples of less than or equal to 5% relative standard deviation (RSD) for peak area counts or peak area ratio and retention time criteria of less than or equal to 2% RSD were met for all analytes.

3.3 Limit of Quantitation (LOQ)

The LOQ as defined in method ETS-8-044.3 is the lowest non-zero calibration standard in the curve that meets linearity and accuracy requirements and for which the area counts are at least twice those of the appropriate blanks. The LOQs associated with the sample analysis are listed in the Table 6 below.

Table 6. LOQ

Analyte	LOQ, ng/mL ⁽¹⁾ 5/17/18 Internal Calibration	LOQ, ng/mL ⁽²⁾ 5/24/18 External Calibration
PFBA	0.0500	2.50
PFOA	0.0240	NA
PFBS	0.0250	NA
PFHS	0.0250	NA
PFOS	0.0232	NA

NA = Not Applicable

(1) A dilution factor of 2 applied to the LOQ.

(2) A dilution factor of 10 applied to the LOQ.

3.4 Continuing Calibration

During the course of the analytical sequence, several continuing calibration verification samples (CCVs) were analyzed to confirm that the instrument response and the initial calibration curve were still in control. All reported results were bracketed by CCVs that met method acceptance criteria of $100\% \pm 25\%$.

3.5 Blanks

Three types of blanks were prepared and analyzed with the samples: method/solvent blanks, field/trip blanks, and sampling equipment blanks. Each blank result was reviewed and used to evaluate method performance. The method/solvent blanks were used to determine the LOQ for each analyte.

3.6 Lab Control Spikes (LCSs)

Low, mid, and high lab control spikes were prepared for the target analytes and analyzed in triplicate. LCSs prepared for internal standard calibration analysis were prepared by spiking known amounts of the analytes into 10 mL of laboratory reagent water to produce the desired concentration. The LCSs were then diluted in the same manner as the samples. Method ETS-8-044.3 states that the average recovery of LCSs at each spiking level must be within 80%-120% with a RSD $\leq 20\%$. All LCS samples met criteria with the following exceptions:

- 5/17/18 Internal Standard Calibration Analysis: The high level LCSs were spiked above the resulting ULOQ for PFBS, PFHS, and PFOS. The low and mid-level LCSs were prepared at a concentration that was more appropriated as compared to the samples, and the data are reported.
- 5/24/18 External Standard Calibration Analysis: One of the three high level LCSs quantitated above the resulting ULOQ for PFBA. If this LCS (128%) were included in the calculation of the average recovery for the high-level LCSs, the average would have been 121%.

All LCS samples that were within the calibration range were used in the determination of the analytical method uncertainty in section 3.7 of the report.

The following calculations were used to generate data in Table 7.

$$\text{LCS Percent Recovery} = \frac{\text{Calculated Concentration}}{\text{Spike Concentration}} * 100\%$$

$$\text{LCS% RSD} = \frac{\text{standard deviation LCS replicates}}{\text{average LCS recovery}} * 100\%$$

Table 7. Laboratory Control Spike Results.

Lab ID	PFBA			PFOA (Linear + Branched)		
	Spiked Concentration (ng/mL)	Calculated Concentration (ng/mL)	%Recovery	Spiked Concentration (ng/mL)	Calculated Concentration (ng/mL)	%Recovery
LCS-180516-1	0.198	0.234	118	0.190	0.202	106
LCS-180516-2	0.198	0.230	117	0.190	0.191	100
LCS-180516-3	0.198	0.220	111	0.190	0.197	104
Average ± %RSD	115% ± 3.3%			103% ± 3.0%		
LCS-180516-4	19.8	18.0	91.2	19.0	18.1	95.2
LCS-180516-5	19.8	18.1	91.3	19.0	17.8	93.8
LCS-180516-6	19.8	17.6	88.7	19.0	17.9	94.3
Average ± %RSD	90.4% ± 1.6%			94.4% ± 0.75%		
LCS-180516-7	139	124	88.9	133	126	94.7
LCS-180516-8	139	125	89.9	133	124	93.2
LCS-180516-9	139	122	88.1	133	124	93.0
Average ± %RSD	89.0% ± 1.0%			93.6% ± 0.99%		

Lab ID	PFBS			PFHS		
	Spiked Concentration (ng/mL)	Calculated Concentration (ng/mL)	%Recovery	Spiked Concentration (ng/mL)	Calculated Concentration (ng/mL)	%Recovery
LCS-180516-1	0.198	0.206	104	0.198	0.208	105
LCS-180516-2	0.198	0.202	102	0.198	0.198	99.9
LCS-180516-3	0.198	0.224	113	0.198	0.202	102
Average ± %RSD	106% ± 5.5%			102% ± 2.5%		
LCS-180516-4	19.8	18.8	94.8	19.8	18.3	92.3
LCS-180516-5	19.8	18.5	93.5	19.8	18.6	93.9
LCS-180516-6	19.8	18.3	92.3	19.8	18.2	9.1
Average ± %RSD	93.5% ± 1.3%			92.8% ± 1.1%		
LCS-180516-7	139	>ULOQ	NA	139	>ULOQ	NA
LCS-180516-8	139	>ULOQ	NA	139	>ULOQ	NA
LCS-180516-9	139	>ULOQ	NA	139	>ULOQ	NA
Average ± %RSD	NA⁽¹⁾			NA⁽¹⁾		

NA = Not Applicable

ULOQ = Upper Limit of Quantification

(1) LCS concentration outside the calibration range.

Table 7 continued. Laboratory Control Spike Results.

ETS-8-044.3 Internal standard Analyzed 5/17/18	PFOS (Linear + Branched)			[¹³ C ₄]-PFOS		
Lab ID	Spiked Concentration (ng/mL)	Calculated Concentration (ng/mL)	%Recovery	Spiked Concentration (ng/mL)	Calculated Concentration (ng/mL)	%Recovery
LCS-180516-1	0.184	0.202	110	0.189	0.192	102
LCS-180516-2	0.184	0.188	102	0.189	0.186	98.3
LCS-180516-3	0.184	0.195	106	0.189	0.187	99.1
Average ± %RSD	106% ± 3.8%			99.8% ± 2.0%		
LCS-180516-4	18.4	17.9	97.3	1.89	1.95	103
LCS-180516-5	18.4	17.4	94.6	1.89	1.90	101
LCS-180516-6	18.4	16.9	92.1	1.89	1.88	99.3
Average ± %RSD	94.7% ± 2.7%			101% ± 1.8%		
LCS-180516-7	129	>ULOQ	NA			
LCS-180516-8	129	>ULOQ	NA			
LCS-180516-9	129	>ULOQ	NA			
Average ± %RSD	NA⁽¹⁾					
ETS-8-044.3 Internal standard Analyzed 5/17/18	[¹³ C ₃]-PFBA			[¹³ C ₄]-PFOA		
Lab ID	Spiked Concentration (ng/mL)	Calculated Concentration (ng/mL)	%Recovery	Spiked Concentration (ng/mL)	Calculated Concentration (ng/mL)	%Recovery
LCS-180516-1	0.197	0.194	98.3	0.198	0.202	102
LCS-180516-2	0.197	0.199	101	0.198	0.194	97.9
LCS-180516-3	0.197	0.202	103	0.198	0.199	100
Average ± %RSD	101% ± 2.3%			100% ± 2.1%		
LCS-180516-4	1.97	2.02	103	1.98	2.04	103
LCS-180516-5	1.97	2.04	103	1.98	2.00	101
LCS-180516-6	1.97	1.99	101	1.98	1.97	99.5
Average ± %RSD	102% ± 1.1%			101% ± 1.7%		

NA = Not Applicable

ULOQ = Upper Limit of Quantification

(1) LCS concentration outside the calibration range.

Table 7 continued. Laboratory Control Spike Results.

Lab ID	PFBA		
	Spiked Concentration (ng/mL)	Calculated Concentration (ng/mL)	%Recovery
LCS-180524-1	20.0	19.0	95.0
LCS-180524-2	20.0	19.6	98.2
LCS-180524-3	20.0	19.9	99.7
Average ± %RSD	97.6% ± 2.5%		
LCS-180524-4	99.0	105	106
LCS-180524-5	99.0	103	104
LCS-180524-6	99.0	112	114
Average ± %RSD	108% ± 4.9%		
LCS-180524-7	398	443	111
LCS-180524-8	398	488	123
LCS-180524-9	398	>ULOQ	NA
Average ± %RPD	117% ± 10%		

NA = Not Applicable

ULOQ = Upper Limit of Quantification

(1) LCS concentration outside the calibration range.

3.7 Analytical Data Uncertainty

Analytical uncertainty is based on historical QC data that is control charted and used to evaluate method accuracy and precision. The method uncertainty is calculated following ETS-12-012.4. The standard deviation is calculated for the set of accuracy results (in %) obtained for the QC samples. For method ETS-8-044.3, the most recent fifty QC samples were used. The expanded uncertainty is calculated by multiplying the standard deviation by a factor of 2, which corresponds to a confidence level of 95%.

Table 8. Analytical Data Uncertainty.

Analyte	Calibration	Standard Deviation (%)	Method Uncertainty
PFBA	Internal	10.8	±22%
PFOA	Internal	4.60	±9.2%
PFBS	Internal	6.58	±13%
PFHS	Internal	6.73	±13%
PFOS	Internal	4.95	±9.9%
PFBA	External	8.89	±18%

3.8 Field Matrix Spikes (FMS)

A target analyte field matrix spike sample was collected at select sampling points to verify that the analytical method is applicable for the collected matrix. Field matrix spikes are generated by adding a measured volume of field sample to a container spiked by the laboratory with the target analytes prior to shipping sample containers for sample collection. Field matrix spikes must be at least 50% of the analyte concentration to be considered an appropriate spike level. Field matrix spike recoveries within method acceptance criteria of $100\pm30\%$ confirm that "unknown" components in the sample matrix do not significantly interfere with the preparation and analysis of the analytes of interest. The standards used for the preparation of the field matrix spiking solutions contained reference materials comprised of both linear and branched isomers for PFOS and PFOA. Field matrix spikes are presented in section 4 of this report.

In addition to target analyte field matrix spikes, a few of the samples contained stable isotope surrogate recovery spikes of [$^{13}\text{C}_3$]-PFBA, [$^{13}\text{C}_4$]-PFOA, and [$^{13}\text{C}_4$]-PFOS, which were added at a nominal concentration of 0.1 ng/mL to select sample bottles prior to sample collection or at a nominal concentration of 1 ng/mL following sample collection. The [$^{13}\text{C}_3$]-PFBA and [$^{13}\text{C}_4$]-PFOA were selected to represent perfluorocarboxylic acids. The [$^{13}\text{C}_4$]-PFOS was selected to represent the perfluorosulfonic acids. Surrogate matrix spike recoveries within method acceptance criteria of $100\pm30\%$ confirm that "unknown" components in the sample matrix do not significantly interfere with the preparation and analysis of the analytes of interest. The surrogate spike recoveries are included in section 4 of this report.

$$\text{FMS Recovery} = \frac{\text{Sample Conc. of FMS} - \text{Average Conc. (Field Sample & Field Sample Dup)}}{\text{Spike Conc.}} \times 100\%$$

Table 9. Field Matrix Spike Concentrations

Location	Spike Level	Final Concentration (ng/mL)				
		PFBA	PFBS	PFHS	PFOA	PFOS
MW-1-81	FMS	0.250	0.250	0.250	0.250	0.250
MW-1-93, PW-24	FMS	2.00	2.00	2.00	2.00	2.00
Bldg 1 Coffee Sink, PW-112	FMS	5.00	5.00	5.00	5.00	5.00
MW-8-94	FMS	10.0	10.0	10.0	10.0	10.0
MW-1-79, MW-7-90	FMS	20.0	20.0	20.0	20.0	20.0
Trip Blank	Low	0.250	0.250	0.250	0.250	0.250
	High	20.0	20.0	20.0	20.0	20.0

4 Data Summary and Discussion

Tables 10-18 below summarize the sample results and field matrix spike (or lab matrix spike) recoveries for sampling locations as well as the Trip Blank. Each table provides the average concentration and the relative percent difference (%RPD) of the sample and sample duplicate. Results and average values are rounded to three significant figures. Percent relative difference (%RPD) values are rounded to two significant figures. Because of rounding, values vary slightly from those listed in the raw data. Field matrix spikes meeting the method acceptance criteria of $\pm 30\%$, demonstrate that the method is appropriate for the given matrix. Tables 19 summarize the results for the surrogate recovery standards analyzed with each analytical batch.

The method indicates that the target analyte FMS samples should be spiked at approximately 0.5-10 times the expected analyte concentration in the sample. The field matrix spike concentration was selected based on the expected concentration of PFOA and/or PFOS, based on previous results for the Cottage Grove site. In instances where the FMS spike level is >10 times the endogenous amounts, the FMS recovery is reported and flagged as above 10 times the sample concentration.

For those analytes where the field matrix spike level was not appropriate as compared to the sample concentration, the surrogate recovery standards were used to assess method accuracy. All surrogate recovery standards for each sample set and field matrix spike recoveries met method acceptance criteria.

Rinseate Blank (COIL-GW-MW-4-94-RB02-0-180424) result: The rinseate blank contained a detectable level of PFBA at 0.0598 ng/mL. The rinseate blank was collected on 4/24/18 at 12:30, after the collection of location MW-7-90 at 12:30 and prior to the collection of MW-4-94 at 13:00. The average PFBA concentration for location MW-7-90 was 39.1 ng/mL and the average PFBA concentration for location MW-4-94 was 29.8 ng/mL. The PFBA concentration in the rinse blank was 0.2% of the average PFBA concentration in location MW-4-94 ($0.0598 \text{ ng/mL} / 29.8 \text{ ng/mL} * 100\%$). The carryover from location MW-7-90 to location MW-4-94 is negligible.

Samples collected on 4/24/18 had average PFBA concentrations ranging from 3.64 ng/mL (MW-1-88) to 232 ng/mL (MW-4-81). Assuming a 0.2% PFBA carryover between each sample set, at most, the carryover from location MW-4-81 would be 0.466 ng/mL. However, location MW-4-81 was the last sample set collected on 4/24/18.

Table 10. C01L-GW-MW-1-79 180425 (1)

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-001	C01L-GW-MW-1-79-0-180425	90.4	NA	2.58	NA
ISO18-16-01-001-DUP	C01L-GW-MW-1-79-DB-180425	90.2	NA	2.42	NA
ISO18-16-01-001-FMS	C01L-GW-MW-1-79-FMS-180425	109	NC	19.8	86.5
Average Concentration (ng/mL) ± %RPD		90.3 ng/mL ± 0.22%		2.50 ng/mL ± 6.4%	
3M LIMS ID	Description	PFBS		PFHS	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-001	C01L-GW-MW-1-79-0-180425	7.88	NA	4.02	NA
ISO18-16-01-001-DUP	C01L-GW-MW-1-79-DB-180425	7.82	NA	4.00	NA
ISO18-16-01-001-FMS	C01L-GW-MW-1-79-FMS-180425	25.6	88.8	21.4	87.0
Average Concentration (ng/mL) ± %RPD		7.85 ng/mL ± 0.76%		4.01 ng/mL ± 0.50%	
40.1 ng/mL ± 5.5%					

NA = Not Applicable

NC = Not Calculated; endogenous sample concentration was greater than 2x the spike level.

(1) Samples analyzed by internal standard calibration.

Table 11. COIL-GW-MW-1-81 180423⁽¹⁾

		PFBA		PFOA ⁽²⁾	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-005	COIL-GW-MW-1-81-0-180423	0.0868	NA	<0.0240	NA
ISO18-16-01-005-DUP	COIL-GW-MW-1-81-DB-180423	0.0770	NA	<0.0240	NA
ISO18-16-01-005-FMS	COIL-GW-MW-1-81-FMS-180423	0.314	92.8	0.218	87.2
Average Concentration (ng/mL) ± %RPD		0.0819 ng/mL ± 12%		<0.0240 ng/mL	

		PFBS		PFHIS		PFOS	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-005	COIL-GW-MW-1-81-0-180423	<0.0250	NA	<0.0250	NA	0.0256	NA
ISO18-16-01-005-DUP	COIL-GW-MW-1-81-DB-180423	<0.0250	NA	<0.0250	NA	0.0258	NA
ISO18-16-01-005-FMS	COIL-GW-MW-1-81-FMS-180423	0.232	92.8	0.218	87.2	0.234	83.3
Average Concentration (ng/mL) ± %RPD		<0.0250 ng/mL		<0.0250 ng/mL		0.0257 ng/mL ± 0.78%	

NA = Not Applicable

(1) Samples analyzed by internal standard calibration except noted otherwise.

Table 12. COIL-GW-MW-7-90 180424.⁽¹⁾

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-009	COIL-GW-MW-7-90-0-180424	39.2	NA	0.840	NA
ISO18-16-01-009-DUP	COIL-GW-MW-7-90-DB-180424	39.0	NA	0.842	NA
ISO18-16-01-009-FMS	COIL-GW-MW-7-90-FMS-180424	57.8	93.5	17.6 ⁽²⁾	83.8
Average Concentration (ng/mL) ± %RPD		39.1 ng/mL ± 0.51%		0.841 ng/mL ± 0.24%	
3M LIMS ID	Description	PFBS		PFOS	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-009	COIL-GW-MW-7-90-0-180424	1.01	NA	2.64	NA
ISO18-16-01-009-DUP	COIL-GW-MW-7-90-DB-180424	1.01	NA	2.62	NA
ISO18-16-01-009-FMS	COIL-GW-MW-7-90-FMS-180424	18.7 ⁽²⁾	88.5	20.2	87.9
Average Concentration (ng/mL) ± %RPD		1.01 ng/mL ± 0.0%		2.63 ng/mL ± 0.76%	19.6 ng/mL ± 1.0%

NA = Not Applicable

(1) Samples analyzed by external standard calibration.

(2) FMS spike level was greater than 10x the endogenous sample concentration.

Table 13. COIL-GW-MW-1-93 180424⁽¹⁾

		PFBA		PFOA	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-011	COIL-GW-MW-1-93-0-180424	4.06	NA	0.0536	NA
ISO18-16-01-011-DUP	COIL-GW-MW-1-93-DB-180424	4.10	NA	0.0504	NA
ISO18-16-01-011-FMS	COIL-GW-MW-1-93-FMS-180424	6.06	99.0	1.79 ⁽²⁾	86.9
Average Concentration (ng/mL) ± %RPD		4.08 ng/mL ± 0.98%		0.0520 ng/mL ± 6.2%	
		PFBS		PFHs	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-011	COIL-GW-MW-1-93-0-180424	0.0892	NA	0.266	NA
ISO18-16-01-011-DUP	COIL-GW-MW-1-93-DB-180424	0.0980	NA	0.274	NA
ISO18-16-01-011-FMS	COIL-GW-MW-1-93-FMS-180424	1.87 ⁽²⁾	88.8	1.93	83.0
Average Concentration (ng/mL) ± %RPD		0.0936 ng/mL ± 9.4%		0.270 ng/mL ± 3.0%	
		PFOS		PFOS	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-011	COIL-GW-MW-1-93-0-180424	0.0892	NA	0.936	NA
ISO18-16-01-011-DUP	COIL-GW-MW-1-93-DB-180424	0.0980	NA	0.938	NA
ISO18-16-01-011-FMS	COIL-GW-MW-1-93-FMS-180424	1.87 ⁽²⁾	88.8	1.93	83.0
Average Concentration (ng/mL) ± %RPD		0.0936 ng/mL ± 9.4%		0.270 ng/mL ± 3.0%	
		0.937 ng/mL ± 0.21%		0.937 ng/mL ± 0.21%	

NA = Not Applicable

(1) Samples analyzed by internal standard calibration.

(2) FMS spike level was greater than 10x the endogenous sample concentration.

Table 14. COIL-GW-MW-8-94 180423⁽¹⁾

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-015	COIL-GW-MW-8-94-0-180423	17.7	NA	0.336	NA
ISO18-16-01-015-DUP	COIL-GW-MW-8-94-DB-180423	17.7	NA	0.312	NA
ISO18-16-01-015-FMS	COIL-GW-MW-8-94-FMS-180423	28.8	111	8.82 ⁽²⁾	85.0
Average Concentration (ng/mL) ± %RPD		17.7 ng/mL ± 0.0%		0.324 ng/mL ± 7.4%	

3M LIMS ID	Description	PFBS		PFHxS		PFOS	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-015	COIL-GW-MW-8-94-0-180423	0.264	NA	0.866	NA	6.46	NA
ISO18-16-01-015-DUP	COIL-GW-MW-8-94-DB-180423	0.262	NA	0.834	NA	6.20	NA
ISO18-16-01-015-FMS	COIL-GW-MW-8-94-FMS-180423	9.16	89.0	9.58	87.3	15.9	95.7
Average Concentration (ng/mL) ± %RPD		0.263 ng/mL ± 0.76%		0.850 ng/mL ± 3.8%		6.33 ng/mL ± 4.1%	

NA = Not Applicable

(1) Samples analyzed by external standard calibration.

(2) FMS spike level was greater than 10x the endogenous sample concentration.

Table 15. COIL-GW-MW-4-81 180424⁽¹⁾

3M LIMS ID	Description	PFBA	
		Concentration (ng/mL)	%Recovery
ISO18-16-01-018	COIL-GW-MW-4-81-0-180424	259	NA
ISO18-16-01-018-DUP	COIL-GW-MW-4-81-DB-180424	246	NA
ISO18-16-01-018-LMS	Lab Matrix Spike	464	106
Average Concentration (ng/mL) ± %RPD		253 ng/mL ± 5.1%	

NA = Not Applicable

(1) Samples analyzed by external standard calibration.

Table 16. COIL-GW-PW-112-180425 (1)

		PFBA		PFOA	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-021	COIL-GW-PW-112-0-180425	0.830	NA	0.0946	NA
ISO18-16-01-021-DUP	COIL-GW-PW-112-DB-180425	0.780	NA	0.0894	NA
ISO18-16-01-021-FMS	COIL-GW-PW-112-FMS-180425	5.48	93.5	4.28 ⁽²⁾	83.8
Average Concentration (ng/mL) ± %RPD		0.805 ng/mL ± 6.2%		0.0920 ng/mL ± 5.7%	

		PFBS		PFHS		PFOS	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-021	COIL-GW-PW-112-0-180425	<0.0250	NA	0.156	NA	2.20	NA
ISO18-16-01-021-DUP	COIL-GW-PW-112-DB-180425	<0.0250	NA	0.150	NA	1.94	NA
ISO18-16-01-021-FMS	COIL-GW-PW-112-FMS-180425	4.38 ⁽²⁾	87.6	4.52 ⁽²⁾	87.3	6.48	88.2
Average Concentration (ng/mL) ± %RPD		<0.0250 ng/mL		0.153 ng/mL ± 3.9%		2.07 ng/mL ± 13%	

NA = Not Applicable

- (1) Samples analyzed by internal standard calibration.
(2) FMS spike level was greater than 10x the endogenous sample concentration.

Table 17. COIL-GW-Bldg 1 Coffee Sink 180425⁽¹⁾

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-026	COIL-GW-Bldg 1 Coffee Sink-0-180425	7.44	NA	0.390	NA
ISO18-16-01-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB-180425	7.28	NA	0.368	NA
ISO18-16-01-026-FMS	COIL-GW-Bldg 1 Coffee Sink-FMS-180425	11.9	90.8	4.78 ⁽²⁾	88.0
Average Concentration (ng/mL) ± %RPD		7.36 ng/mL ± 2.2%		0.379 ng/mL ± 5.8%	
3M LIMS ID	Description	PFBS		PFOS	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-026	COIL-GW-Bldg 1 Coffee Sink-0-180425	0.950	NA	0.606	NA
ISO18-16-01-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB-180425	0.956	NA	0.588	NA
ISO18-16-01-026-FMS	COIL-GW-Bldg 1 Coffee Sink-FMS-180425	5.40	88.9	5.06	89.3
Average Concentration (ng/mL) ± %RPD		0.953 ng/mL ± 0.63%		0.597 ng/mL ± 3.0%	
7.60 ng/mL ± 3.2%					

NA = Not Applicable

(1) Samples analyzed by internal standard calibration.

(2) FMS spike level was greater than 10x the endogenous sample concentration.

Table 18. CGMN GW Trip Blank⁽¹⁾

		PFBA		PFOA	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-01-027	COIL-GW-TRIP-0-180419	<0.0500	NA	<0.0240	NA
ISO18-16-01-027-FMS-LOW	COIL-GW-TRIP-FMS Low-180419	0.238	95.2	0.218	87.2
ISO18-16-01-027-FMS-HIGH	COIL-GW-TRIP-FMS High-180419	18.5	92.5	17.1	85.5

		PFBS		PFHS		PFOS	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO11-01-03-33-022	CGMN-GW-TRIP-0-180323	<0.0250	NA	<0.0250	NA	<0.0232	NA
ISO11-01-03-33-022-FMS-LOW	CGMN-GW-TRIP-FMS-L-180323	0.216	86.4	0.218	87.2	0.212	84.8
ISO11-01-03-33-022-FMS-HIGH	CGMN-GW-TRIP-FMS-H-180323	17.8	89.0	17.7	88.5	17.0	85.0

NA = Not Applicable

(1) Samples analyzed by internal standard calibration except noted otherwise.

Table 19. Surrogate Recovery Standard Results by Internal Calibration

3M LIMS ID	Sample Description	Percent Recovery (%)		
		[¹³ C ₃]-PFBA	[¹³ C ₄]-PFOA	[¹³ C ₄]-PFOS
ISO18-16-01-001	COIL-GW-MW-1-79-0-180425	91.7	86.2	88.4
ISO18-16-01-001-DUP	COIL-GW-MW-1-79-DB-180425	89.0	86.0	85.9
ISO18-16-01-001-FMS	COIL-GW-MW-1-79-FMS-180425	87.8	88.0	85.7
ISO18-16-01-002	COIL-GW-MW-3-79-0-180423	90.9	87.6	86.5
ISO18-16-01-002-DUP	COIL-GW-MW-3-79-DB-180423	91.9	97.4	89.0
ISO18-16-01-003	COIL-GW-MW-4-79-0-180423	92.5	94.4	87.1
ISO18-16-01-003-DUP	COIL-GW-MW-4-79-DB-180423	89.4	87.6	91.7
ISO18-16-01-004	COIL-GW-MW-5-79-0-180423	84.4	83.0	91.9
ISO18-16-01-004-DUP	COIL-GW-MW-5-79-DB-180423	91.3	88.4	88.2
ISO18-16-01-005	COIL-GW-MW-1-81-0-180423	90.9	87.4	89.8
ISO18-16-01-005-DUP	COIL-GW-MW-1-81-DB-180423	89.2	90.8	88.4
ISO18-16-01-005-FMS	COIL-GW-MW-1-81-FMS-180423	94.3	86.6	89.2
ISO18-16-01-006	COIL-GW-MW-3-81-0-180423	88.2	91.2	86.5
ISO18-16-01-006-DUP	COIL-GW-MW-3-81-DB-180423	92.5	91.8	85.0
ISO18-16-01-007	COIL-GW-MW-1-88-0-180424	87.8	78.8	98.0
ISO18-16-01-007-DUP	COIL-GW-MW-1-88-DB-180424	88.8	83.8	87.7
ISO18-16-01-008	COIL-GW-MW-2-90-0-180424	91.7	89.8	87.5
ISO18-16-01-008-DUP	COIL-GW-MW-2-90-DB-180424	89.6	85.8	90.5
ISO18-16-01-009	COIL-GW-MW-7-90-0-180424	91.7	91.6	90.9
ISO18-16-01-009-DUP	COIL-GW-MW-7-90-DB-180424	88.6	94.2	91.1
ISO18-16-01-009-FMS	COIL-GW-MW-7-90-FMS-180424	86.4	90.2	88.6
ISO18-16-01-010	COIL-GW-MW-9-90R-0-180424	92.1	94.4	91.1
ISO18-16-01-010-DUP	COIL-GW-MW-9-90R-DB-180424	90.5	96.0	90.3
ISO18-16-01-011	COIL-GW-MW-1-93-0-180424	92.9	94.2	89.4
ISO18-16-01-011-DUP	COIL-GW-MW-1-93-DB-180424	88.0	86.6	85.7
ISO18-16-01-011-FMS	COIL-GW-MW-1-93-FMS-180424	93.1	91.6	90.9
ISO18-16-01-012	COIL-GW-MW-3-94-0-180424	92.7	87.8	93.8
ISO18-16-01-012-DUP	COIL-GW-MW-3-94-DB-180424	84.8	84.0	93.2
ISO18-16-01-013	COIL-GW-MW-4-94-0-180424	90.7	89.6	86.3
ISO18-16-01-013-DUP	COIL-GW-MW-4-94-DB-180424	90.3	82.6	91.1
ISO18-16-01-014	COIL-GW-MW-7-94-0-180424	88.2	82.4	84.4
ISO18-16-01-014-DUP	COIL-GW-MW-7-94-DB-180424	88.0	92.4	90.7
ISO18-16-01-015	COIL-GW-MW-8-94-0-180423	89.0	90.8	89.0
ISO18-16-01-015-DUP	COIL-GW-MW-8-94-DB-180423	90.7	89.6	88.2
ISO18-16-01-015-FMS	COIL-GW-MW-8-94-FMS-180423	87.2	82.0	92.1
ISO18-16-01-016	COIL-GW-MW-9-94-0-180423	88.2	80.8	88.2
ISO18-16-01-016-DUP	COIL-GW-MW-9-94-DB-180423	86.8	88.0	88.0
ISO18-16-01-017	COIL-GW-MW-2-81-0-180423	92.5	87.6	91.5
ISO18-16-01-017-DUP	COIL-GW-MW-2-81-DB-180423	87.8	90.0	89.6
ISO18-16-01-018	COIL-GW-MW-4-81-0-180424	83.8	85.4	91.3
ISO18-16-01-018-DUP	COIL-GW-MW-4-81-DB-180424	86.0	82.8	86.5
ISO18-16-01-019	COIL-GW-MW-5-81-0-180423	86.0	84.4	89.4
ISO18-16-01-019-DUP	COIL-GW-MW-5-81-DB-180423	90.5	83.8	86.3

Table 19 continued. Surrogate Recovery Standard Results by Internal Calibration

3M LIMS ID	Sample Description	Percent Recovery (%)		
		[¹³ C ₃]-PFBA	[¹³ C ₄]-PFOA	[¹³ C ₄]-PFOS
ISO18-16-01-020	COIL-GW-PW-11-0-180425	87.2	83.4	84.4
ISO18-16-01-020-DUP	COIL-GW-PW-11-DB-180425	88.2	77.6	84.0
ISO18-16-01-021	COIL-GW-PW-112-0-180425	88.0	83.6	87.3
ISO18-16-01-021-DUP	COIL-GW-PW-112-DB-180425	89.2	87.4	86.1
ISO18-16-01-021-FMS	COIL-GW-PW-112-FMS-180425	94.7	89.2	90.5
ISO18-16-01-022	COIL-GW-PW-113-0-180425	87.6	87.4	83.4
ISO18-16-01-022-DUP	COIL-GW-PW-113-DB-180425	91.9	84.8	89.6
ISO18-16-01-023	COIL-GW-PW-37-0-180425	102	105	98.8
ISO18-16-01-023-DUP	COIL-GW-PW-37-DB-180425	92.9	82.2	86.1
ISO18-16-01-024	COIL-GW-PW-91-0-180425	86.0	92.4	85.0
ISO18-16-01-024-DUP	COIL-GW-PW-91-DB-180425	90.5	97.2	94.0
ISO18-16-01-025	COIL-GW-PW-94-0-180425	85.6	88.6	88.0
ISO18-16-01-025-DUP	COIL-GW-PW-94-DB-180425	86.2	92.2	86.5
ISO18-16-01-026	COIL-GW-Bldg 1 Coffee Sink-0-180425	87.6	89.4	85.7
ISO18-16-01-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB-180425	90.5	95.2	85.4
ISO18-16-01-026-FMS	COIL-GW-Bldg 1 Coffee Sink-FMS-180425	93.3	90.2	91.3
ISO18-16-01-027	COIL-GW-TRIP-0-180419	91.1	84.0	90.5
ISO18-16-01-027-FMS-LOW	COIL-GW-TRIP-FMS Low-180419	91.3	95.0	94.7
ISO18-16-01-027-FMS-HIGH	COIL-GW-TRIP-FMS High-180419	85.6	91.0	90.5
ISO18-16-01-028	COIL-GW-MW-3-79-RB01-0-180423	89.6	86.6	91.1
ISO18-16-01-029	COIL-GW-MW-4-94-RB02-0-180424	96.3	91.2	87.5

5 Conclusion

Laboratory control spikes were used to determine the analytical method accuracy and precision for all analytes. The accuracy and precision were then used to estimate the method uncertainty for the results. Field matrix spike recoveries demonstrated that the analytical method was appropriate for the given sample matrix except where noted. Analysis was completed using 3M EHS Laboratory method ETS-8-044.3 "Method of Analysis for the Determination of Perfluorinated Compounds in Water by LC/MS/MS; Direct Injection Analysis". Analytical results are reported in Tables 1 and 10-19 of this report.

6 Data / Sample Retention

All remaining sample and associated project data (hardcopy and electronic) will be archived according to 3M EHS Laboratory standard operating procedures.

7 Attachments

- Attachment A: Historical Trend Chart
- Attachment B: Chain of Custody Form

8 Signatures

Susan T. Wolf, 3M Principal Analytical Investigator and Report Author

Brian T. Mader, Ph.D., 3M EHS Laboratory Manager

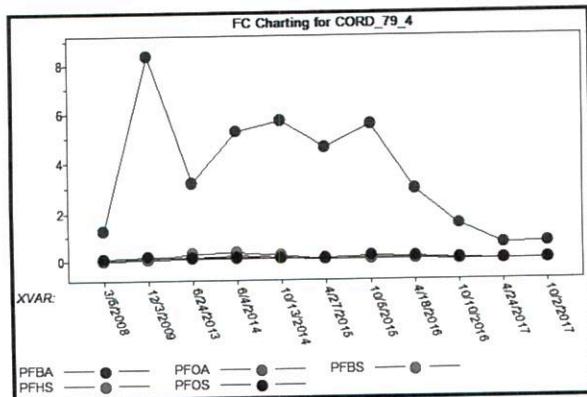
The 3M EHS Laboratory's Quality Assurance Unit has audited the data and report for this project.

Quality Assurance Representative

This test report shall not be reproduced except in full, without written approval of the 3M EHS Laboratory.

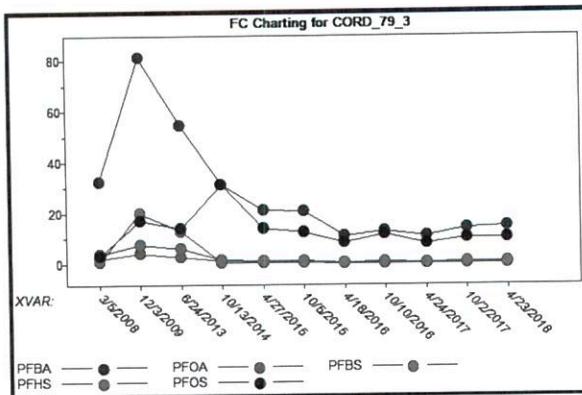
Attachment A: Historical Trend Chart

MW-1-79



MW-1-79	3/5/08	12/2/09	6/25/13	6/4/14	10/13/14	4/28/15	10/7/15	4/18/16	10/11/16	4/25/17	10/4/17	4/25/18
PFBA	135	240	152	174	184	166	157	94.7	93.9	84.4	91.7	90.3
PFOA	6.60	21.0	14.0	9.52	6.24	5.34	4.85	2.68	1.93	1.91	2.73	2.50
PFBS	2.50	2.57	2.89	6.80	41.8	33.7	35.3	20.9	14.0	9.49	7.55	7.85
PFHS	9.72	14.3	17.1	11.4	9.50	9.16	7.45	4.28	4.02	3.62	3.99	4.01
PFOS	22.2	24.4	29.6	33.0	45.9	43.4	37.3	32.3	33.5	33.9	37.8	40.1

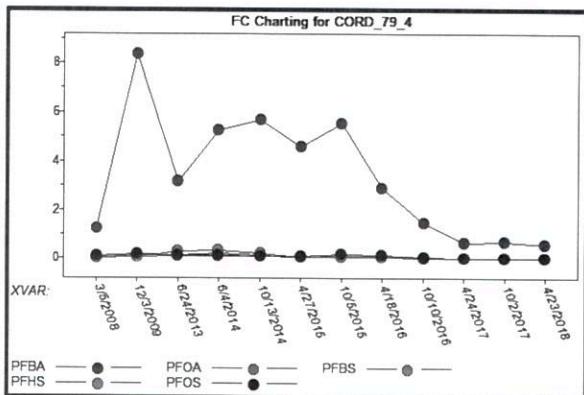
MW-3-79



MW-3-79	3/5/08	12/3/09	6/24/13	10/13/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18
PFBA	32.0	81.1	54.4	31.1	21.0	20.6	10.9	12.8	10.8	13.9	14.6
PFOA	2.17	4.10	2.87	1.46	0.901	0.815	0.388	0.379	0.296	0.362	0.402
PFBS	0.756	19.8	12.9	0.574	0.368	0.480	0.172	0.100	0.166	0.141	0.185
PFHS	3.95	7.55	5.93	1.67	1.34	1.12	0.698	0.754	0.593	0.735	0.832
PFOS	3.22	16.9	13.9	31.0	13.9	12.5	8.34	11.8	8.09	10.3	10.2

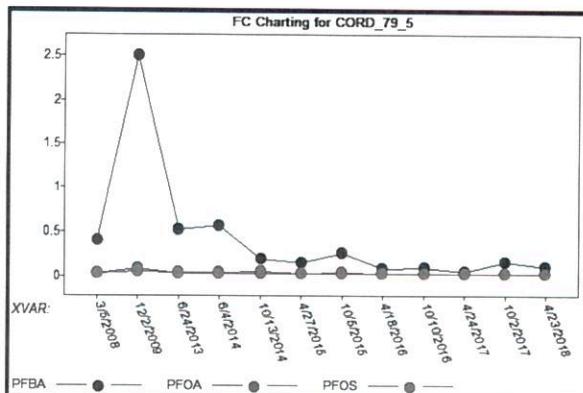
Attachment A: Historical Trend Chart

MW-4-79



MW-4-79	3/5/08	12/3/09	6/24/13	6/4/14	10/13/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18
PFBA	1.22	8.35	3.16	5.26	5.69	4.57	5.52	2.87	1.49	0.639	0.691	0.571
PFOA	0.0320	0.123	0.154	0.219	0.127	0.0511	0.0607	0.0605	<0.0240	<0.0240	<0.0240	<0.0240
PFBS	0.0250	0.0533	0.0861	0.0973	0.0885	0.0711	0.105	0.0897	<0.0250	<0.0250	<0.0250	<0.0250
PFHS	0.0339	0.0460	0.275	0.314	0.203	0.0569	0.0803	0.0615	<0.0250	<0.0250	<0.0250	<0.0250
PFOS	0.0786	0.174	0.121	0.151	0.111	0.0807	0.169	0.145	0.0553	<0.0232	<0.0232	0.0340

MW-5-79

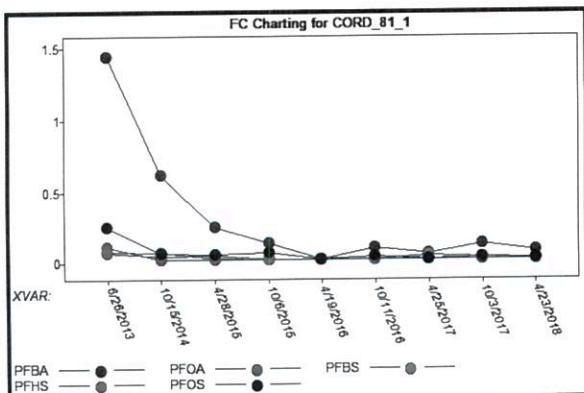


MW-5-79	3/5/08	12/2/09	6/24/13	6/4/14	10/13/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18
PFBA	0.400	<2.50	0.528	0.571	0.190	0.153	0.255	0.0845	<0.100	<0.0500	0.156	0.111
PFOA	<0.0298	0.0865	0.0259	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240
PFOS	<0.0250	0.0548	0.0448	0.0346	0.0539	0.0246	0.0435	<0.0232	<0.0232	<0.0232	<0.0232	0.0269

PFBS and PFHS were not detected above the reporting limit for these sampling events.

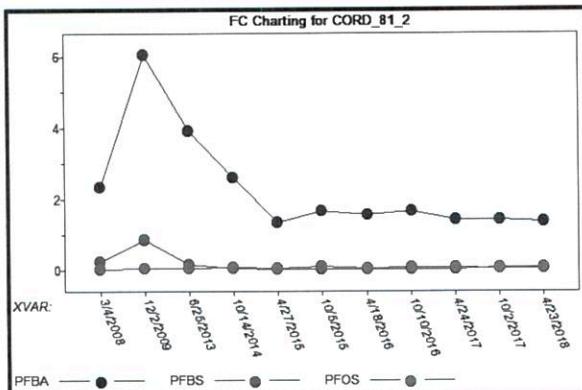
Attachment A: Historical Trend Chart

MW-1-81



MW-1-81	6/26/13	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/23/18
PFBA	1.44	0.615	0.250	0.138	<0.0250	<0.100	0.0636	0.131	0.0819
PFOA	0.108	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240
PFBS	0.0775	0.0660	0.0294	<0.0250	<0.0250	<0.0250	0.0456	0.0325	<0.0250
PFHS	0.0706	0.0409	<0.0500	<0.0236	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
PFOS	0.247	0.0614	0.0583	0.0699	<0.0232	0.0400	<0.0232	0.0366	0.0257

MW-2-81

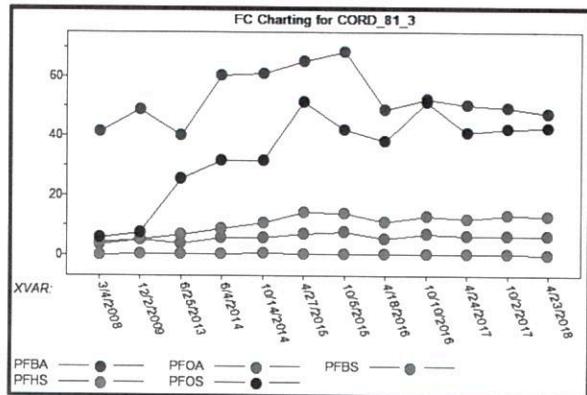


MW-2-81	3/4/08	12/2/09	6/25/13	10/14/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18
PFBA	2.34	6.04	3.92	2.60	1.34	1.66	1.57	1.67	1.43	1.44	1.38
PFBS	0.260	0.870	0.163	0.0767	0.0364	<0.0250	0.0371	<0.0250	<0.0250	0.0976	0.0886
PFOS	<0.0250	0.0538	0.0609	0.103	0.0613	0.114	0.0571	0.0996	0.0867	0.0671	0.0677

PFOA and PFHS were not detected above the reporting limit for during these sampling events.

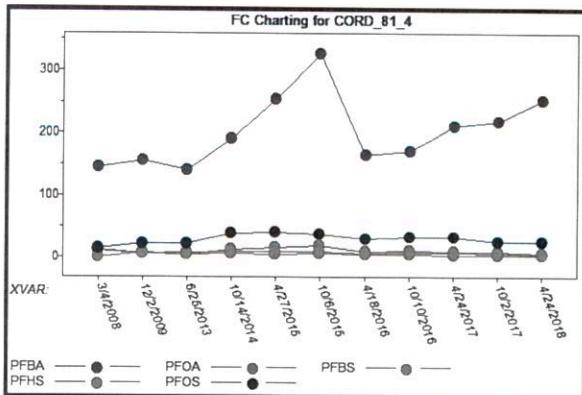
Attachment A: Historical Trend Chart

MW-3-81



MW-3-81	3/4/08	12/2/09	6/25/13	6/4/14	10/14/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18
PFBA	41.3	48.7	40.0	60.3	61.0	65.0	68.2	48.5	52.2	50.4	49.4	47.5
PFOA	3.56	5.19	3.98	5.84	5.97	7.22	7.85	5.75	7.26	6.56	6.62	6.63
PFBS	0.189	0.357	0.356	0.371	0.635	0.424	0.410	0.305	0.330	0.342	0.335	0.290
PFHS	4.32	5.40	6.95	8.67	10.7	14.4	13.8	11.1	12.9	12.0	13.2	12.9
PFOS	5.94	7.54	25.5	31.5	31.7	51.3	41.8	38.2	51.3	40.8	42.1	42.4

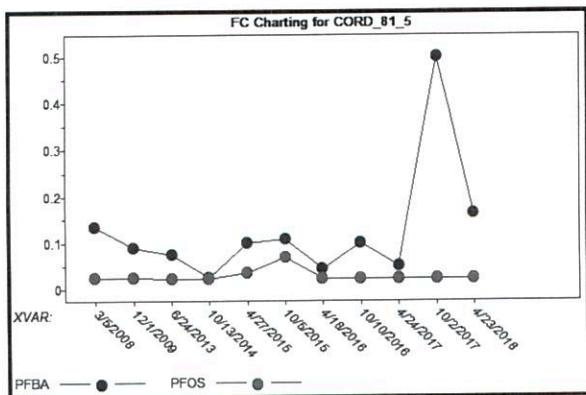
MW-4-81



MW-4-81	3/4/08	12/2/09	6/25/13	10/14/14	4/27/15	10/6/15	4/18/16	10/10/16	4/24/17	10/2/17	4/24/18
PFBA	145	155	140	191	254	326	165	171	211	219	253
PFOA	12.1	6.25	5.8	6.05	5.63	6.69	4.44	4.82	4.21	3.41	2.94
PFBS	0.829	7.73	5.88	13.5	15.6	18.7	10.5	12.0	9.83	9.66	7.16
PFHS	11.6	6.99	7.49	9.86	9.96	9.89	6.99	7.67	7.80	6.65	5.92
PFOS	13.7	21.5	22.5	39.3	40.5	37.5	29.6	33.0	32.1	25.4	25.3

Attachment A: Historical Trend Chart

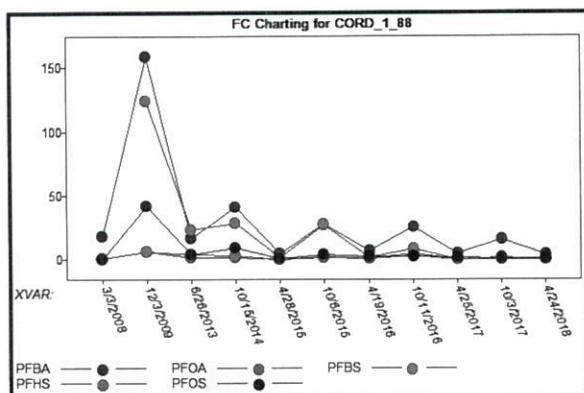
MW-5-81



MW-5-81	3/5/08	12/1/09	6/24/13	10/13/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18
PFBA	0.135	0.0891	0.0744	<0.0250	<0.100	0.108	0.0436	<0.100	<0.0500	<0.500	0.163
PFOS	<0.0250	<0.0253	<0.0232	<0.0232	0.0347	0.0689	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232

PFOA, PFBS and PFHS were not detected above the reporting limit for during these sampling events.

MW-1-88

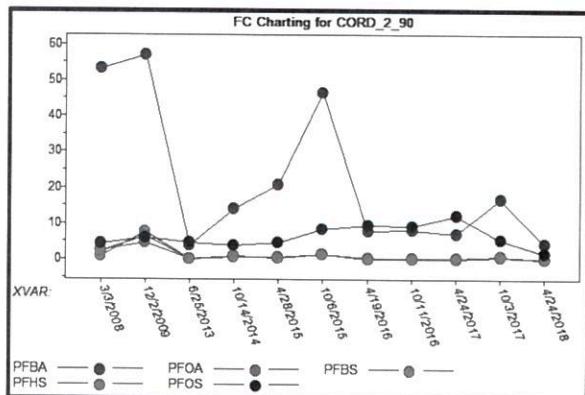


MW-1-88	3/3/08	12/3/09	6/26/13	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18
PFBA	17.5	158	16.3	41.2	4.21	27.2	6.83	25.4	4.25	15.7	3.64
PFOA	0.519	5.84	1.29	1.56	0.122	1.11	0.459	2.77	0.112	0.199	<0.0240
PFBS	NR	124	23.4	28.5	1.51	26.6	1.34	7.91	0.0982	1.64	<0.0250
PFHS	0.630	6.04	3.38	3.23	0.161	1.81	0.735	4.70	0.112	0.469	<0.0250
PFOS	0.142	41.8	3.43	9.16	0.720	3.52	1.88	2.25	1.28	0.868	0.452

NR = Not Reported; The recovery of the field matrix spike did not meet method criteria for data reportability.

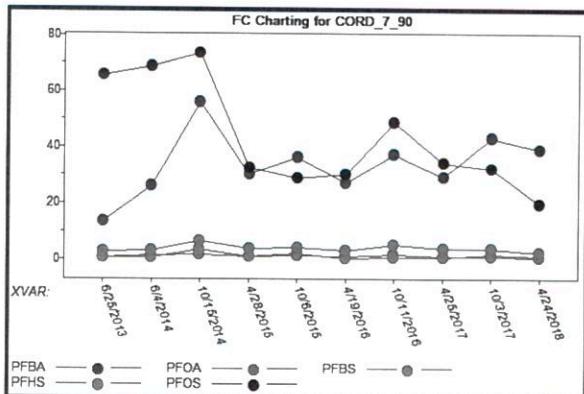
Attachment A: Historical Trend Chart

MW-2-90



MW-2-90	3/3/08	12/2/09	6/25/13	10/14/14	4/28/15	10/6/15	4/19/16	10/11/16	4/24/17	10/3/17	4/24/18
PFBA	53.1	56.9	3.79	13.9	20.6	46.5	7.77	8.11	7.10	16.7	4.28
PFOA	2.36	4.50	0.0770	0.772	0.306	1.38	0.154	0.103	0.154	0.746	0.0970
PFBS	0.937	7.54	0.0882	0.519	0.455	1.41	0.183	0.206	0.164	0.603	0.104
PFHS	2.29	6.50	0.0770	0.782	0.300	1.34	0.146	0.155	0.190	0.861	0.103
PFOS	4.46	5.91	4.55	3.84	4.51	8.31	9.37	9.27	12.1	5.29	1.53

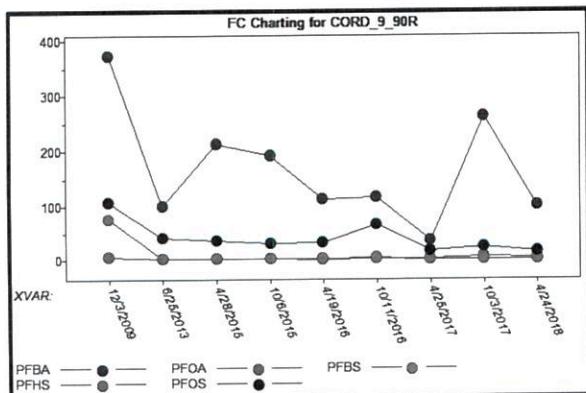
MW-7-90



MW-7-90	6/25/13	6/4/14	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18
PFBA	13.7	26.1	55.9	30.2	36.3	26.9	37.2	29.2	43.1	39.1
PFOA	0.946	1.35	1.90	1.07	1.43	1.08	1.72	1.19	1.08	0.841
PFBS	0.738	0.886	3.56	1.06	2.10	0.512	0.800	0.649	1.86	1.01
PFHS	2.85	3.17	6.69	4.00	4.19	3.26	5.11	3.81	3.90	2.63
PFOS	65.6	68.8	73.4	32.5	28.8	29.9	48.7	34.1	32.1	19.6

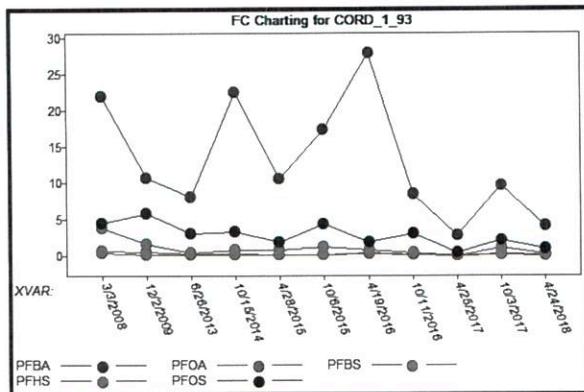
Attachment A: Historical Trend Chart

MW-9-90R



MW-9-90R	12/3/09	6/25/13	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18
PFBA	372	99.8	213	192	112	116	35.0	261	101
PFOA	6.09	1.86	2.11	1.82	1.19	2.43	0.480	0.787	0.475
PFBS	76.1	1.84	2.43	2.32	1.02	1.76	1.39	5.42	4.01
PFHS	4.82	2.43	2.02	2.01	1.53	2.86	0.724	1.06	0.765
PFOS	107	40.2	34.5	30.5	31.6	64.8	16.8	23.2	14.2

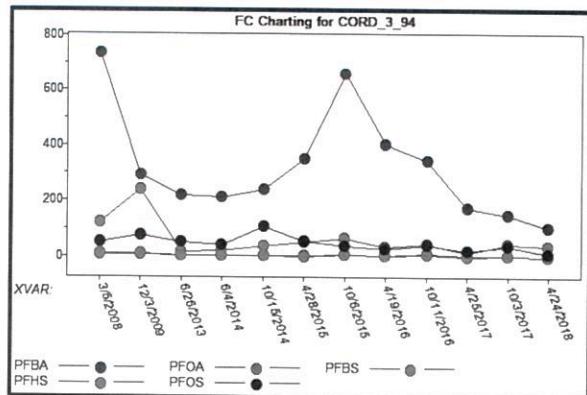
MW-1-93



MW-1-93	3/3/08	12/2/09	6/26/13	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18
PFBA	22.0	10.7	8.05	22.5	10.5	17.4	27.9	8.40	2.74	9.68	4.08
PFOA	0.709	0.497	0.269	0.180	0.150	0.208	0.323	0.148	0.0442	0.174	0.0520
PFBS	0.470	0.217	0.117	0.259	0.127	0.202	0.37	0.0910	0.0468	0.266	0.0936
PFHS	3.78	1.60	0.420	0.841	0.804	1.15	0.753	0.479	0.0515	1.14	0.270
PFOS	4.52	5.75	3.03	3.31	1.84	4.41	1.82	2.99	0.377	2.16	0.937

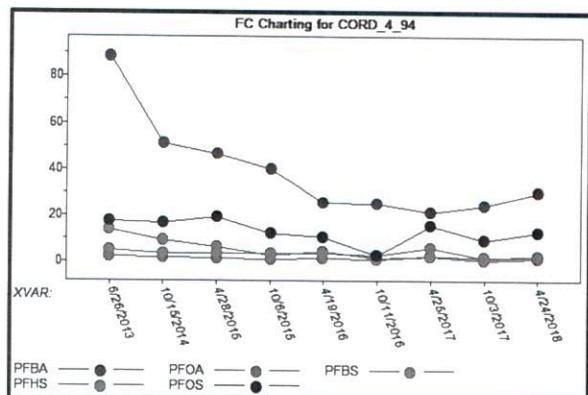
Attachment A: Historical Trend Chart

MW-3-94



MW-3-94	3/5/08	12/3/09	6/26/13	6/4/14	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18
PFBA	734	290	217	213	239	350	658	403	342	174	148	104
PFOA	7.61	6.66	3.19	2.42	5.00	3.45	5.75	5.12	9.53	4.80	3.19	0.899
PFBS	120	238	17.4	20.8	38.9	52.3	64.5	33.1	43.7	15.4	46.1	38.3
PFHS	11.5	8.97	3.21	1.97	3.75	1.52	5.45	3.59	6.21	1.49	2.73	0.765
PFOS	51.8	76.2	52.7	41.7	107	57.1	38.4	29.2	41.9	20.5	36.8	10.2

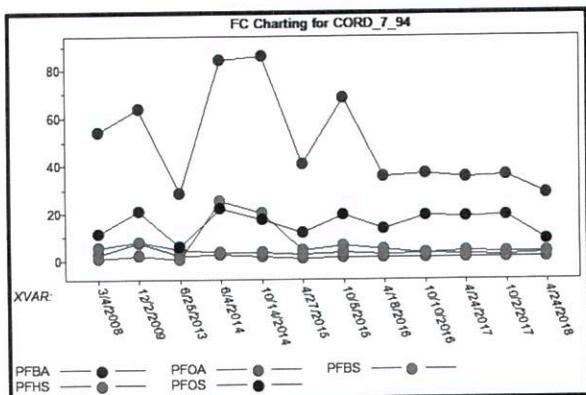
MW-4-94



MW-4-94	6/26/13	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18
PFBA	88.3	51.0	46.4	40.0	25.3	24.9	21.4	24.1	29.8
PFOA	2.29	1.83	1.46	1.11	1.50	1.03	2.39	0.661	1.24
PFBS	14.0	9.48	6.52	2.81	4.15	1.48	2.41	1.72	2.19
PFHS	5.06	3.41	3.41	3.32	3.58	2.83	5.79	1.25	2.29
PFOS	17.7	16.8	19.1	12.2	10.4	2.57	15.7	9.23	12.7

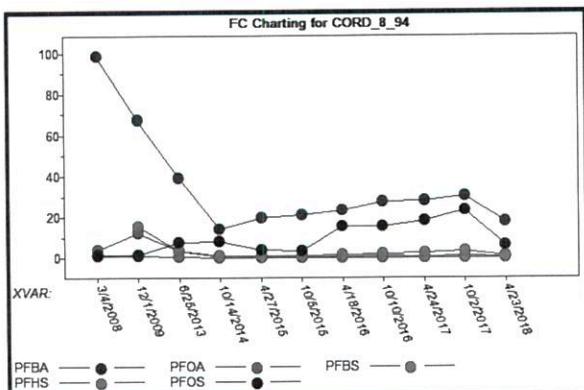
Attachment A: Historical Trend Chart

MW-7-94



MW-7-94	3/4/08	12/2/09	6/25/13	6/4/14	10/14/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/24/18
PFBA	53.7	63.4	28.3	84.2	85.7	40.5	67.9	35.3	36.4	35.0	35.7	28.1
PFOA	2.45	7.23	2.04	2.46	1.50	0.719	1.21	1.03	1.04	1.03	0.910	0.967
PFBS	0.821	1.90	0.311	25.2	20.0	3.74	6.07	4.16	2.52	2.23	1.98	2.86
PFHS	4.98	7.68	4.45	3.07	2.88	2.39	3.21	2.44	2.82	3.30	3.25	3.22
PFOS	11.0	20.8	5.44	22.1	17.3	11.7	19.3	13.2	18.8	18.3	18.7	8.43

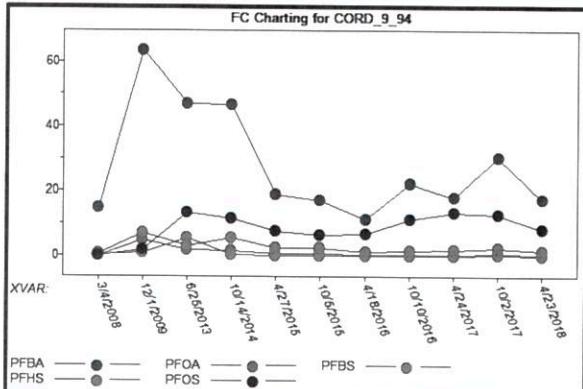
MW-8-94



NR = Not Reported; The recovery of the field matrix spike did not meet method criteria for data reportability.

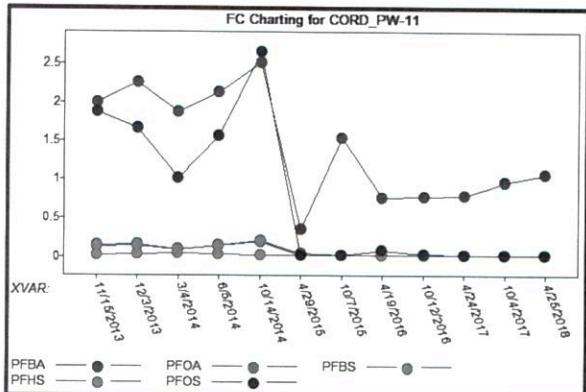
Attachment A: Historical Trend Chart

MW-9-94



MW-9-94	3/4/08	12/1/09	6/25/13	10/14/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18
PFBA	14.8	63.5	46.8	46.4	18.9	17.2	11.2	22.2	18.1	30.2	17.4
PFOA	0.0986	4.79	1.88	1.62	0.786	0.767	0.371	0.368	0.352	0.613	0.473
PFBS	0.199	0.894	5.41	0.398	0.151	0.138	0.0993	0.155	0.148	0.250	0.158
PFHS	0.763	6.91	2.99	5.32	2.53	2.32	1.28	1.51	1.74	2.56	1.49
PFOS	0.0878	1.93	13.1	11.4	7.39	6.20	6.49	11.0	13.1	12.6	7.98

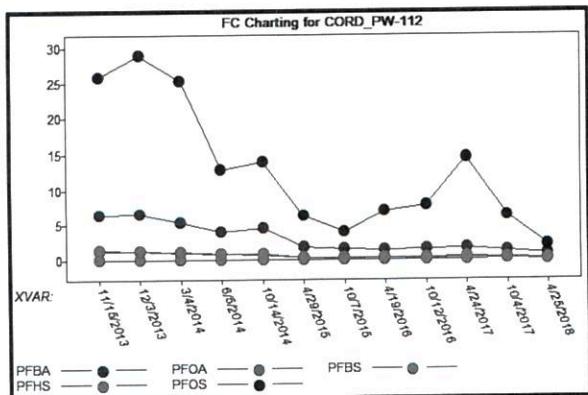
PW11



PW11	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18
PFBA	2.00	2.26	1.87	2.13	2.51	0.357	1.53	0.766	0.772	0.791	0.963	1.06
PFOA	0.139	0.146	0.0899	0.144	0.199	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240
PFBS	<0.0250	0.0293	<0.0500	0.0386	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
PFHS	0.144	0.159	0.0976	0.140	0.213	<0.0500	<0.0236	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
PFOS	1.87	1.66	1.01	1.56	2.65	<0.0232	0.0247	0.0845	0.0379	<0.0232	0.0260	<0.0232

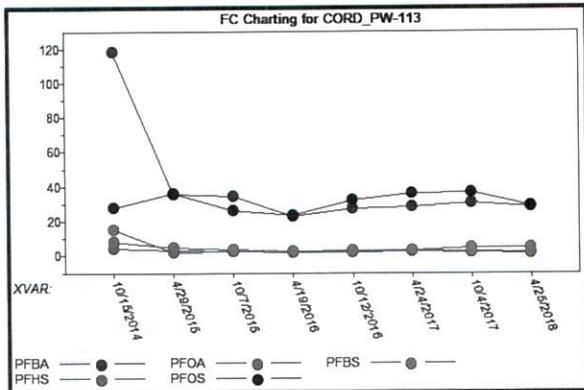
Attachment A: Historical Trend Chart

PW112



PW-112	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18
PFBA	6.43	6.51	5.30	3.92	4.49	1.83	1.52	1.39	1.47	1.69	1.28	0.805
PFOA	1.19	1.21	0.960	0.778	0.725	0.215	0.191	0.225	0.201	0.261	0.199	0.0920
PFBS	0.0509	0.0662	<0.0500	0.0408	0.0421	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.100	<0.0250
PFHS	1.33	1.29	1.06	0.785	0.810	0.256	0.280	0.330	0.317	0.434	0.324	0.153
PFOS	25.8	28.9	25.3	12.8	13.9	6.29	3.95	6.97	7.82	14.4	6.33	2.07

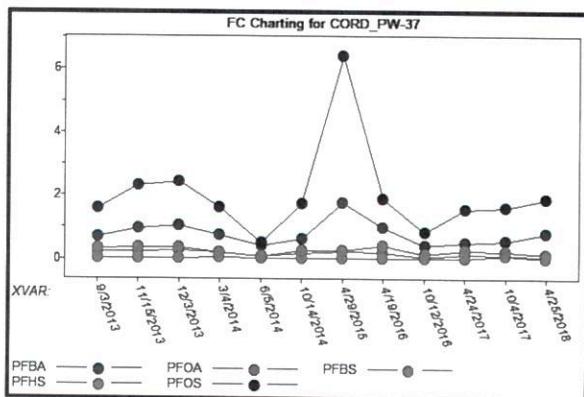
PW113



PW-113	10/15/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18
PFBA	118	35.4	34.5	22.6	27.0	28.3	30.6	28.4
PFOA	4.05	2.99	2.39	1.86	2.08	2.21	1.81	1.39
PFBS	14.8	1.67	2.35	1.87	2.42	3.03	4.49	4.42
PFHS	7.64	4.58	3.57	2.66	2.89	3.05	2.65	2.06
PFOS	27.8	35.8	26.1	23.6	32.2	35.8	36.4	29.1

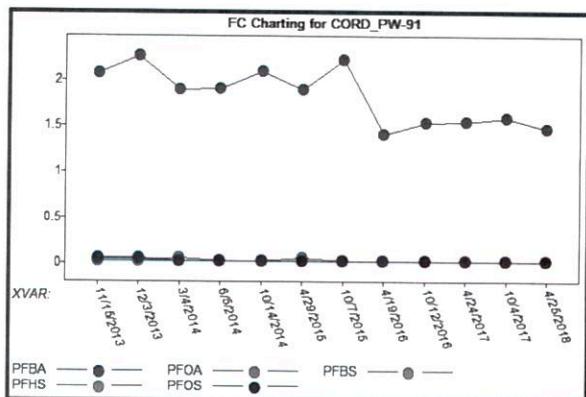
Attachment A: Historical Trend Chart

PW37



PW-37	9/3/13	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18
PFBA	0.691	0.949	1.05	0.749	0.418	0.623	1.78	0.977	0.422	0.489	0.561	0.788
PFOA	0.219	0.243	0.264	0.193	0.0657	0.177	0.219	0.188	0.0624	0.139	0.115	0.0865
PFBS	<0.0250	<0.0250	0.0307	<0.0500	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.100	<0.0250
PFHS	0.308	0.35	0.361	0.209	0.0715	0.258	0.262	0.418	0.133	0.266	0.221	0.146
PFOS	1.60	2.31	2.42	1.62	0.506	1.73	6.40	1.88	0.822	1.55	1.63	1.88

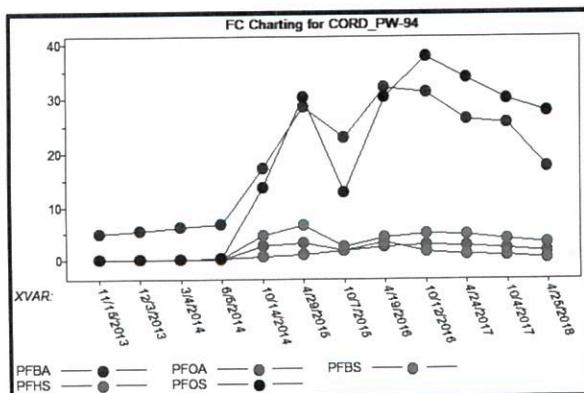
PW91



PW-91	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18
PFBA	2.07	2.26	1.89	1.90	2.09	1.89	2.22	1.41	1.53	1.54	1.59	1.47
PFOA	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240
PFBS	<0.0250	<0.0250	<0.0500	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
PFHS	<0.0500	<0.0500	<0.0250	<0.0250	<0.0250	<0.0500	<0.0236	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
PFOS	<0.0464	<0.0464	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232

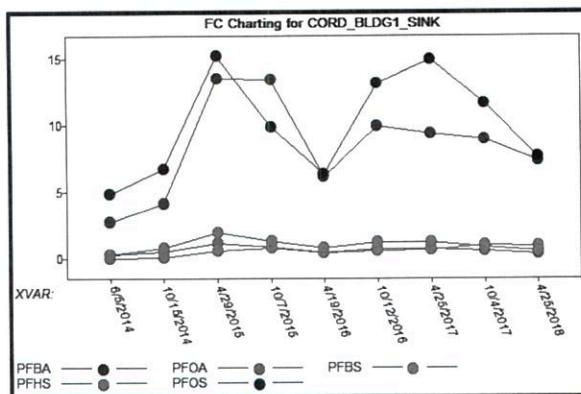
Attachment A: Historical Trend Chart

PW94



PW-94	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18
PFBA	4.86	5.39	6.07	6.53	17.0	28.4	22.7	32.0	31.2	26.2	25.5	17.3
PFOA	<0.0240	<0.0240	<0.0240	0.0682	2.48	3.06	1.59	2.33	2.73	2.47	2.03	1.50
PFBS	0.0569	0.0727	0.0703	0.0978	0.470	0.798	1.54	3.24	1.46	0.848	0.740	0.251
PFHS	<0.0500	<0.0500	<0.0250	0.0859	4.38	6.36	2.39	4.16	4.80	4.55	3.79	2.96
PFOS	<0.0464	<0.0464	<0.0232	0.238	13.5	30.3	12.6	30.2	37.7	33.8	29.9	27.5

Building 1 Coffee Sink



Bldg 1 Coffee Sink	6/5/14	10/15/14	4/29/15	10/7/15	4/19/16	10/12/16	4/25/17	10/4/17	4/25/18
PFBA	2.71	4.13	13.5	13.4	6.14	9.94	9.33	8.90	7.36
PFOA	0.320	0.541	1.19	0.886	0.445	0.770	0.771	0.563	0.379
PFBS	0.0325	0.0665	0.621	0.801	0.474	0.626	0.693	1.05	0.953
PFHS	0.312	0.781	1.99	1.30	0.787	1.24	1.22	0.873	0.597
PFOS	4.81	6.66	15.2	9.81	6.35	13.1	14.9	11.6	7.60

3M EHS LABORATORY
Chain-of-Custody

Project: ISO18-16-01

Requester: Blomquist, Karie Lyn (MAPLEWOOL)
 Department: 108100 Site Source: 01L1M100
 Project Number:
 Date Created: 4/18/2018
 Project Description: Cordova PFC Groundwater Monitoring
 Copy List: Sheller, Patricia M (CORDOVA-3MUS-IL)

Comments:

Shipping Address:
 3M EHS Laboratory
 3M Center, Bldg 260-5N-17
 St. Paul, MN 55144

Phone: (651) 733-9873
 Alt. Phone: (651) 736-6559
 Fax: (651) 733-4687

Completion Date:
 Project Lead: Susan T. Wolf
 Phone Number: 651-733-9851
 Email Address: stwolf@mmm.com

<u>3M Sample Number</u>	<u>Sample Description</u>	<u>Date/Time Sampled</u>	<u>Matrix</u>	<u>Comment</u>
ISO18-16-01-001	COIL-GW-MW-1-79-0- 180425	4-25-18 / 09:45	W	
ISO18-16-01-001-DUP	COIL-GW-MW-1-79-DB- 180425			
ISO18-16-01-001-FMS	COIL-GW-MW-1-79-FMS- 180425	↓	↓	
ISO18-16-01-002	COIL-GW-MW-3-79-0- 180423	4-23-18 / 13:35		
ISO18-16-01-002-DUP	COIL-GW-MW-3-79-DB- 180423	↓	↓	
ISO18-16-01-003	COIL-GW-MW-4-79-0- 180423	4-23-18 / 12:20		
ISO18-16-01-003-DUP	COIL-GW-MW-4-79-DB- 180423	↓	↓	
ISO18-16-01-004	COIL-GW-MW-5-79-0- 180423	4-23-18 / 11:25		
ISO18-16-01-004-DUP	COIL-GW-MW-5-79-DB- 180423	↓	↓	
ISO18-16-01-005	COIL-GW-MW-1-81-0- 180424	4-24-18 / 10:20		
ISO18-16-01-005-DUP	COIL-GW-MW-1-81-DB- 180424	↓	↓	
ISO18-16-01-005-FMS	COIL-GW-MW-1-81-FMS- 180424	↓	↓	
ISO18-16-01-006	COIL-GW-MW-3-81-0- 180423	4-23-18 / 15:40		
ISO18-16-01-006-DUP	COIL-GW-MW-3-81-DB- 180423	↓	↓	↓

Sample Condition Upon Receipt: Acceptable All items accounted forTemperature: 4 Deg C Received on Ice Other:

Collected by (print): DAVE CAIRNS

Collector's signature: 

Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time
	Dave Cairns	4/27/18	09:00		S26	27 APR 2018	09:00

3M EHS LABORATORY
Chain-of-Custody

Shipping Address:
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3M Center, Bldg 260-5N-17
St. Paul, MN 55144

Phone: (651) 733-9873
Alt. Phone: (651) 736-6559
Fax: (651) 733-4687

Project: ISO18-16-01 (cont.)

Requester: Blomquist, Karie Lyn (MAPLEWOI)
Department: 108100 Site Source: 01L1M100
Project Number:
Date Created: 4/18/2018
Project Description: Cordova PFC Groundwater Monitoring

Completion Date:
Project Lead: Susan T. Wolf
Phone Number: 651-733-9851
Email Address: stwolf@mmm.com

<u>3M Sample Number</u>	<u>Sample Description</u>	<u>Date/Time Sampled</u>	<u>Matrix</u>	<u>Comment</u>
ISO18-16-01-007	COIL-GW-MW-1-88-0- 180424	4-24-2018 / 11:45	W	
ISO18-16-01-007-DUP	COIL-GW-MW-1-88-DB- 180424	↓	↓	
ISO18-16-01-008	COIL-GW-MW-2-90-0- 180424	4-24-2018 / 04:00		
ISO18-16-01-008-DUP	COIL-GW-MW-2-90-DB- 180424	↓	↓	
ISO18-16-01-009	COIL-GW-MW-7-90-0- 180424	4-24-2018 / 12:20		
ISO18-16-01-009-DUP	COIL-GW-MW-7-90-DB- 180424	↓	↓	
ISO18-16-01-009-FMS	COIL-GW-MW-7-90-FMS- 180424			
ISO18-16-01-010	COIL-GW-MW-9-90R-0- 180424	4-24-2018 / 13:55		
ISO18-16-01-010-DUP	COIL-GW-MW-9-90R-DB- 180424	↓	↓	
ISO18-16-01-011	COIL-GW-MW-1-93-0- 180424	4-24-2018 / 11:15		
ISO18-16-01-011-DUP	COIL-GW-MW-1-93-DB- 180424	↓	↓	
ISO18-16-01-011-FMS	COIL-GW-MW-1-93-FMS- 180424			
ISO18-16-01-012	COIL-GW-MW-3-94-0- 180424	4-24-2018 / 13:30		
ISO18-16-01-012-DUP	COIL-GW-MW-3-94-DB- 180424	↓	↓	
ISO18-16-01-013	COIL-GW-MW-4-94-0- 180424	4-24-2018 / 13:00		
ISO18-16-01-013-DUP	COIL-GW-MW-4-94-DB- 180424	↓	↓	
ISO18-16-01-014	COIL-GW-MW-7-94-0- 180424	4-24-2018 / 08:10	~	

Temperature: 4 Deg C

Acceptable

All items accounted for

Received on Ice

Other:

Collected by (print):

DAVE CIRNS

Collector's signature:

Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time
	Dave CIRNS	4/21/18	0900		SS	27 APR 2018	0900

Page 2 of 5

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3M EHS LABORATORY
Chain-of-Custody

Shipping Address:
 3M EHS Laboratory
 3M Center, Bldg 260-5N-17
 St. Paul, MN 55144

Phone: (651) 733-9873
 Alt. Phone: (651) 736-6559
 Fax: (651) 733-4687

Project: ISO18-16-01 (cont.)

Requester: Blomquist, Karie Lyn (MAPLEWOOL)
 Department: 108100 Site Source: 01L1M100
 Project Number:
 Date Created: 4/18/2018
 Project Description: Cordova PFC Groundwater Monitoring

Completion Date:
 Project Lead: Susan T. Wolf
 Phone Number: 651-733-9851
 Email Address: stwolff@mmm.com

<u>3M Sample Number</u>	<u>Sample Description</u>	<u>Date/Time Sampled</u>	<u>Matrix</u>	<u>Comment</u>
ISO18-16-01-014-DUP	COIL-GW-MW-7-94-DB- 180424	4-24-2018 / 08:10	W	
ISO18-16-01-015	COIL-GW-MW-8-94-0- 180423	4-23-2018 / 16:35		
ISO18-16-01-015-DUP	COIL-GW-MW-8-94-DB- 180423			
ISO18-16-01-015-FMS	COIL-GW-MW-8-94-FMS- 180423	↓	↓	
ISO18-16-01-016	COIL-GW-MW-9-94-0- 180423	4-23-18 / 16:10		
ISO18-16-01-016-DUP	COIL-GW-MW-9-94-DB- 180423	↓	↓	
ISO18-16-01-017	COIL-GW-MW-2-81-0- 180423	4-23-18 / 14:55		
ISO18-16-01-017-DUP	COIL-GW-MW-2-81-DB- 180423	↓	↓	
ISO18-16-01-018	COIL-GW-MW-4-81-0- 180424	4-24-18 / 16:30		
ISO18-16-01-018-DUP	COIL-GW-MW-4-81-DB- 180424	↓	↓	
ISO18-16-01-019	COIL-GW-MW-5-81-0- 180423	4-23-18 / 16:10		SLIGHT OVERFILL
ISO18-16-01-019-DUP	COIL-GW-MW-5-81-DB- 180423	↓	↓	SLIGHT OVERFILL
ISO18-16-01-020	COIL-GW-PW-11-0- 180425	4-25-18 / 08:30		
ISO18-16-01-020-DUP	COIL-GW-PW-11-DB- 180425	↓	↓	
ISO18-16-01-021	COIL-GW-PW-112-0- 180425	4-25-18 / 08:45		
ISO18-16-01-021-DUP	COIL-GW-PW-112-DB- 180425	↓	↓	
ISO18-16-01-021-FMS	COIL-GW-PW-112-FMS- 180425	↓	↓	

ISO18-16-01-014-DUP	COIL-GW-MW-7-94-DB- 180424	4-24-2018 / 08:10	W	
ISO18-16-01-015	COIL-GW-MW-8-94-0- 180423	4-23-2018 / 16:35		
ISO18-16-01-015-DUP	COIL-GW-MW-8-94-DB- 180423			
ISO18-16-01-015-FMS	COIL-GW-MW-8-94-FMS- 180423	↓	↓	
ISO18-16-01-016	COIL-GW-MW-9-94-0- 180423	4-23-18 / 16:10		
ISO18-16-01-016-DUP	COIL-GW-MW-9-94-DB- 180423	↓	↓	
ISO18-16-01-017	COIL-GW-MW-2-81-0- 180423	4-23-18 / 14:55		
ISO18-16-01-017-DUP	COIL-GW-MW-2-81-DB- 180423	↓	↓	
ISO18-16-01-018	COIL-GW-MW-4-81-0- 180424	4-24-18 / 16:30		
ISO18-16-01-018-DUP	COIL-GW-MW-4-81-DB- 180424	↓	↓	
ISO18-16-01-019	COIL-GW-MW-5-81-0- 180423	4-23-18 / 16:10		SLIGHT OVERFILL
ISO18-16-01-019-DUP	COIL-GW-MW-5-81-DB- 180423	↓	↓	SLIGHT OVERFILL
ISO18-16-01-020	COIL-GW-PW-11-0- 180425	4-25-18 / 08:30		
ISO18-16-01-020-DUP	COIL-GW-PW-11-DB- 180425	↓	↓	
ISO18-16-01-021	COIL-GW-PW-112-0- 180425	4-25-18 / 08:45		
ISO18-16-01-021-DUP	COIL-GW-PW-112-DB- 180425	↓	↓	
ISO18-16-01-021-FMS	COIL-GW-PW-112-FMS- 180425	↓	↓	

Sample Condition Upon Receipt: Acceptable All items accounted forTemperature: 4 Deg C Received on Ice Other:Collected by (print): DAVE CATHERS Collector's signature: M. D. Cather

Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time
	<u>DAVE</u>	4/27/18	09:00		<u>✓</u>	27 APR 2018	09:00

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Attachment B: Chain of Custody Form

3M EHS LABORATORY
Chain-of-Custody

Shipping Address:
3M EHS Laboratory
3M Center, Bldg 260-5N-17
St. Paul, MN 55144

Phone: (651) 733-9873
Alt. Phone: (651) 736-6559
Fax: (651) 733-4687

Project: ISO18-16-01 (cont.)

Requester: Blomquist, Karie Lyn (MAPLEWOOL)
Department: 108100 Site Source: 01L1M100
Project Number:
Date Created: 4/18/2018
Project Description: Cordova PFC Groundwater Monitoring

Completion Date:
Project Lead: Susan T. Wolf
Phone Number: 651-733-9851
Email Address: stwolff@mmm.com

<u>3M Sample Number</u>	<u>Sample Description</u>	<u>Date/Time Sampled</u>	<u>Matrix</u>	<u>Comment</u>
ISO18-16-01-022	COIL-GW-PW-113-0- 180425	4-25-18 / 08:15	(W)	
ISO18-16-01-022-DUP	COIL-GW-PW-113-DB- 180425	↓	↓	
ISO18-16-01-023	COIL-GW-PW-37-0- 180425	4-25-18 / 08:50		
ISO18-16-01-023-DUP	COIL-GW-PW-37-DB- 180425	↓	↓	
ISO18-16-01-024	COIL-GW-PW-91-0- 180425	4-25-18 / 08:25		
ISO18-16-01-024-DUP	COIL-GW-PW-91-DB- 180425	↓	↓	
ISO18-16-01-025	COIL-GW-PW-94-0- 180425	4-25-18 / 08:05		
ISO18-16-01-025-DUP	COIL-GW-PW-94-DB- 180425	↓	↓	
ISO18-16-01-026	COIL-GW-Bldg 1 Coffee Sink-0- 180425	4-25-18 / 10:10		
ISO18-16-01-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB- 180425	↓	↓	
ISO18-16-01-026-FMS	COIL-GW-Bldg 1 Coffee Sink-FMS- 180425			
ISO18-16-01-027	COIL-GW-TRIP-0 - 180419	4/19/18 1:56 PM		*
ISO18-16-01-027-FMS-HIGH	COIL-GW-TRIP-FMS High - 180419	4/19/18 1:56 PM		*
ISO18-16-01-027-FMS-LOW	COIL-GW-TRIP-FMS Low - 180419	4/19/18 1:56 PM		*
ISO18-16-01-028	COIL-GW- ^{MW-3-} ₇₉ -RB01-0- 180423	4/23/18 12:35		COIL-GW-MW-3-79- RB01-0-180423
ISO18-16-01-029	COIL-GW- ^{MW-4-} ₉₄ -RB02-0- 180424	4/24/18 12:30	+	COIL-GW-MW-4-94- RB02-0-180424
ISO18-16-01-030	COIL-GW-PW-24-0- NOT	SAMPLED		it

* Trip Blank samples prepared by the 3M EHS Laboratory with the bottle order.

Sample Condition Upon Receipt: Acceptable All items accounted for

Temperature: 4 Deg C Received on Ice Other:

Collected by (print): DAVE CAIRNSCollector's signature: DAVE

Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time
	<u>DAVE CAIRNS</u>	4/27/18	0900		<u>SARAH</u>	27APR2018	0900

Attachment B: Chain of Custody Form

3M EHS LABORATORY
Chain-of-Custody

Shipping Address:
 3M EHS Laboratory
 3M Center, Bldg 260-5N-17
 St. Paul, MN 55144

Phone: (651) 733-9873
 Alt. Phone: (651) 736-6559
 Fax: (651) 733-4687

Project: ISO18-16-01 (cont.)

Requester: Blomquist, Karie Lyn (MAPLEWOOL)
 Department: 108100 Site Source: 01L1M100
 Project Number:
 Date Created: 4/18/2018

Project Description: Cordova PFC Groundwater Monitoring

Completion Date:
 Project Lead: Susan T. Wolf
 Phone Number: 651-733-9851
 Email Address: stwolf@mmm.com

<u>3M Sample Number</u>	<u>Sample Description</u>	<u>Date/Time Sampled</u>	<u>Matrix</u>	<u>Comment</u>
ISO18-16-01-030-DUP	COIL-GW-PW-24-DB-	NOT	SAMPLED	AC
ISO18-16-01-030-FMS	COIL-GW-PW-24-FMS-	NOT	SAMPLED	AC

Sample Condition Upon Receipt: Acceptable All items accounted for
 Temperature: 4 Deg C Received on Ice Other:

Collected by (print):	Collector's signature:						
Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time
<u>Dave Martin</u>		4/18/18	0900		<u>BG</u>	4/18/2018	0900

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- October 2018 Laboratory Analytical Data

Final Report

Analysis of PFBA, PFOA, PFBS, PFHS, and PFOS 3M Cordova Groundwater Wells

October 2018 Sampling

Laboratory Request Number: ISO18-16-02

Report Date – Date of Last Signature

Testing Laboratory

3M Environment, Health, Safety & Medical
3M EHS Laboratory
Building 260-5N-17
Maplewood, MN 55144-1000

Requester

Karie Blomquist
3M Building 224-5W-17
Saint Paul, MN 55144-1000
Phone: (651) 737-3477



The testing reported herein meet the requirements of ANSI/ISO/IEC 17025:2005 "General Requirements for the Competence of Testing and Calibration Laboratories", in accordance with A2LA Certificate # 2052.01. Additionally, the laboratory's quality system has been audited and was determined to be in conformance with the EPA GLPs (40 CFR 792) by an independent A2LA assessment.

3M EHS Laboratory

3M EHS Laboratory Manager: Brian T. Mader, Ph.D.
3M Principal Analytical Investigator and Report Author: Susan Wolf

Analytical Report ISO18-16-02

Analysis of PFBA, PFOA, PFBS, PFHS, and PFOS
3M Cordova Groundwater Wells
October 2018 Sampling

Report Date: Date of Last Signature

1 Introduction/Summary

The 3M Environmental, Health and Safety (EHS) Laboratory prepared and analyzed groundwater samples collected by Weston Solutions personnel at the 3M Cordova facility. Samples were collected October 1-3, 2018. Samples were returned to the 3M EHS Laboratory on October 4, 2018, on ice for the analysis of Perfluorobutanoic acid (PFBA), Perfluorooctanoic acid (PFOA), Perfluorobutane sulfonate (PFBS), Perfluorohexane sulfonate (PFHS) and Perfluorooctane sulfonate (PFOS) under laboratory project number ISO18-16-02.

The 3M EHS Laboratory prepared sample containers for thirty-three sampling locations. Residential well 23321 was not sampled. Each empty container was marked with a "fill to here" line that corresponded to a final volume of 200 mL. Containers reserved for field matrix spikes were fortified with an appropriate matrix spike solution containing the target analytes prior to being sent to the field for sample collection. Select sample bottles were fortified with internal standards and surrogate recovery standards prior to being sent to the field for sample collection.

Samples were prepared and analyzed for PFBA, PFOA, PFBS, PFHS, and PFOS using method ETS-8-044.3 "Method of Analysis for the Determination of Perfluorinated Compounds in Water by LC/MS/MS; Direct Injection Analysis". Internal standards were used to aid in the data quality objectives for the analysis of select samples, where applicable.

Table 1 summarizes the sample results using the analytical method identified above. All results for quality control samples prepared and analyzed with the samples will be reported and discussed elsewhere in this report.



The testing reported herein meet the requirements of ANSI/ISO/IEC 17025:2005 "General Requirements for the Competence of Testing and Calibration Laboratories", in accordance with A2LA Certificate # 2052.01. Additionally, the laboratory's quality system has been audited and was determined to be in conformance with the EPA GLPs (40 CFR 792) by an independent A2LA assessment.

Table 1. Sample Results Summary ⁽¹⁾

3M LIMS ID	Sample Description	PFBA Concentration (ng/mL)	PFOA Concentration (ng/mL)	PFBS Concentration (ng/mL)	PFHS Concentration (ng/mL)	PFOS Concentration (ng/mL)
Monitoring Wells (MW)						
ISO18-16-02-001	COIL-GW-MW-1-79-0-181003	96.0	2.44	9.22	4.68	38.6
ISO18-16-02-001-DUP	COIL-GW-MW-1-79-DB-181003	93.2	2.48	9.02	4.44	37.2
		Average	94.6	2.46	9.12	4.56
		%RPD Sample/Sample Dup	3.0	1.6	2.2	5.3
ISO18-16-02-002	COIL-GW-MW-3-79-0-181001	13.3	0.330	0.181	0.956	13.0
ISO18-16-02-002-DUP	COIL-GW-MW-3-79-DB-181001	13.4	0.322	0.186	0.964	13.6
		Average	13.4	0.326	0.184	0.960
		%RPD Sample/Sample Dup	0.75	2.5	2.7	0.83
ISO18-16-02-003	COIL-GW-MW-4-79-0-181001	0.392	<0.0240	<0.0500	<0.0250	0.0386
ISO18-16-02-003-DUP	COIL-GW-MW-4-79-DB-181001	0.374	<0.0240	<0.0500	<0.0250	0.0296
		Average	0.383	<0.0240	<0.0500	<0.0250
		%RPD Sample/Sample Dup	4.7	NA	NA	26⁽³⁾
ISO18-16-02-004	COIL-GW-MW-5-79-0-181001	<0.100	<0.0240	<0.0500	<0.0250	0.0312
ISO18-16-02-004-DUP	COIL-GW-MW-5-79-DB-181001	<0.100	0.0346	<0.0500	<0.0250	0.0342
		Average	<0.100	0.0346	<0.0500	<0.0250
		%RPD Sample/Sample Dup	NA	NA	NA	9.2
ISO18-16-02-005	COIL-GW-MW-1-81-0-181002	0.151	<0.0240	0.0714	<0.0250	0.0542
ISO18-16-02-005-DUP	COIL-GW-MW-1-81-0-DB-181002	0.160	<0.0240	0.0874	<0.0250	0.0572
		Average	0.156	<0.0240	0.0794	<0.0250
		%RPD Sample/Sample Dup	5.8	NA	20	NA
ISO18-16-02-006	COIL-GW-MW-3-81-0-181001	48.6	6.94	0.418	13.9	41.0
ISO18-16-02-006-DUP	COIL-GW-MW-3-81-0-DB-181001	48.8	6.64	0.444	13.6	39.8
		Average	48.7	6.79	0.431	13.8
		%RPD Sample/Sample Dup	0.41	4.4	6.0	2.2
ISO18-16-02-007	COIL-GW-MW-1-88-0-181002	16.1	0.418	1.63	0.704	2.64
ISO18-16-02-007-DUP	COIL-GW-MW-1-88-DB-181002	16.3	0.414	1.63	0.696	2.76
		Average	16.2	0.416	1.63	0.700
		%RPD Sample/Sample Dup	1.2	0.96	0.0	1.1
ISO18-16-02-008	COIL-GW-MW-2-90-0-181002	12.2	0.306	0.378	0.396	7.14
ISO18-16-02-008-DUP	COIL-GW-MW-2-90-DB-181002	12.1	0.278	0.380	0.406	7.04
		Average	12.2	0.292	0.379	0.401
		%RPD Sample/Sample Dup	0.82	9.6	0.53	2.5
ISO18-16-02-009	COIL-GW-MW-7-90-0-181002	34.8	0.754	1.24	2.64	26.2
ISO18-16-02-009-DUP	COIL-GW-MW-7-90-DB-181002	34.2	0.728	1.19	2.62	25.8
		Average	34.5	0.741	1.22	2.63
		%RPD Sample/Sample Dup	1.7	3.5	4.1	0.76

NA = Not Applicable

- (1) Sample set was analyzed by internal standard calibration, except where noted. The analytical data uncertainties associated with the reported results by internal standard calibration are as follows: PFBA ± 16%, PFOA ± 11%, PFBS ± 13%, PFHS ± 8.3% and PFOS ± 10%.
- (2) Sample set was analyzed by external standard calibration. The analytical data uncertainties associated with the reported results by external standard calibration is as follows: PFBA ± 13%.
- (3) The sample / sample duplicate RPD did not meet method acceptance criteria of ≤20%.

Table 1 continued. Sample Results Summary⁽¹⁾

3M LIMS ID	Sample Description	PFBA Concentration (ng/mL)	PFOA Concentration (ng/mL)	PFBS Concentration (ng/mL)	PFHS Concentration (ng/mL)	PFOS Concentration (ng/mL)
Monitoring Wells (MW)						
ISO18-16-02-010	COIL-GW-MW-9-90R-0-181002	116	0.920	2.08	0.790	15.6
ISO18-16-02-010-DUP	COIL-GW-MW-9-90R-DB-181002	112	0.942	2.02	0.760	15.1
		Average	114	0.931	2.05	0.775
		%RPD Sample/Sample Dup	3.5	2.4	2.9	3.9
ISO18-16-02-011	COIL-GW-MW-1-93-0-181002	2.60	0.0256	0.0578	0.0596	0.332
ISO18-16-02-011-DUP	COIL-GW-MW-1-93-DB-181002	2.62	<0.0240	0.0602	0.0602	0.348
		Average	2.61	0.0256	0.0590	0.0599
		%RPD Sample/Sample Dup	0.77	NA	4.1	1.0
ISO18-16-02-012	COIL-GW-MW-3-94-0-181002	385	2.22	33.0	3.20	24.2
ISO18-16-02-012-DUP	COIL-GW-MW-3-94-DB-181002	376	2.26	33.4	3.30	24.6
		Average	381⁽²⁾	2.24	33.2	3.25
		%RPD Sample/Sample Dup	2.4	1.8	1.2	3.1
ISO18-16-02-013	COIL-GW-MW-4-94-0-181002	25.4	1.41	2.42	2.62	12.3
ISO18-16-02-013-DUP	COIL-GW-MW-4-94-DB-181002	25.2	1.32	2.38	2.66	12.3
		Average	25.3	1.37	2.40	2.64
		%RPD Sample/Sample Dup	0.79	6.6	1.7	0.0
ISO18-16-02-014	COIL-GW-MW-7-94-0-181002	27.6	0.912	2.10	2.38	10.5
ISO18-16-02-014-DUP	COIL-GW-MW-7-94-DB-181002	27.4	0.892	2.10	2.42	10.5
		Average	27.5	0.902	2.10	2.40
		%RPD Sample/Sample Dup	0.73	2.2	0.0	1.7
ISO18-16-02-015	COIL-GW-MW-8-94-0-181001	17.1	0.728	0.244	1.93	27.4
ISO18-16-02-015-DUP	COIL-GW-MW-8-94-DB-181001	17.4	0.762	0.294	2.04	29.2
		Average	17.3	0.745	0.269	1.99
		%RPD Sample/Sample Dup	1.7	4.6	19	5.5
ISO18-16-02-016	COIL-GW-MW-9-94-0-181001	12.4	0.246	0.145	0.914	9.10
ISO18-16-02-016-DUP	COIL-GW-MW-9-94-DB-181001	12.2	0.242	0.171	0.926	9.36
		Average	12.3	0.244	0.158	0.920
		%RPD Sample/Sample Dup	1.6	1.6	16	1.3
ISO18-16-02-017	COIL-GW-MW-2-81-0-181001	4.80	<0.0240	0.0720	<0.0250	0.0590
ISO18-16-02-017-DUP	COIL-GW-MW-2-81-DB-181001	4.68	<0.0240	0.0550	<0.0250	0.0546
		Average	4.74	<0.0240	0.0635	<0.0250
		%RPD Sample/Sample Dup	2.5	NA	27⁽³⁾	NA
ISO18-16-02-018	COIL-GW-MW-4-81-0-181001	217	2.64	7.34	5.68	24.6
ISO18-16-02-018-DUP	COIL-GW-MW-4-81-DB-181001	214	2.64	7.62	5.92	23.8
		Average	216⁽²⁾	2.64	7.48	5.80
		%RPD Sample/Sample Dup	1.4	0.0	3.7	4.1

NA = Not Applicable

- (1) Sample set was analyzed by internal standard calibration, except where noted. The analytical data uncertainties associated with the reported results by internal standard calibration are as follows: PFBA \pm 16%, PFOA \pm 11%, PFBS \pm 13%, PFHS \pm 8.3% and PFOS \pm 10%.
- (2) Sample set was analyzed by external standard calibration. The analytical data uncertainties associated with the reported results by external standard calibration is as follows: PFBA \pm 13%.
- (3) The sample / sample duplicate RPD did not meet method acceptance criteria of $\leq 20\%$.

Table 1 continued. Sample Results Summary ⁽¹⁾

3M LIMS ID	Sample Description	PFBA Concentration (ng/mL)	PFOA Concentration (ng/mL)	PFBS Concentration (ng/mL)	PFHS Concentration (ng/mL)	PFOS Concentration (ng/mL)
Monitoring Wells (MW)						
ISO18-16-02-019	COIL-GW-MW-5-81-0-181001	0.206	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-019-DUP	COIL-GW-MW-5-81-DB-181001	0.155	<0.0240	<0.0500	<0.0250	<0.0232
Average		0.181	<0.0240	<0.0500	<0.0250	<0.0232
%RPD Sample/Sample Dup		28⁽³⁾	NA	NA	NA	NA
Production Wells (PW)						
ISO18-16-02-020	COIL-GW-PW-11-0-181003	0.818	<0.0240	<0.0500	<0.0250	0.0486
ISO18-16-02-020-DUP	COIL-GW-PW-11-DB-181003	0.792	<0.0240	<0.0500	<0.0250	0.0628
Average		0.805	<0.0240	<0.0500	<0.0250	0.0557
%RPD Sample/Sample Dup		3.2	NA	NA	NA	25⁽³⁾
ISO18-16-02-021	COIL-GW-PW-112-0-181003	0.802	0.0976	<0.0500	0.184	4.08
ISO18-16-02-021-DUP	COIL-GW-PW-112-DB-181003	1.05	0.123	<0.0500	0.236	4.66
Average		0.926	0.110	<0.0500	0.210	4.37
%RPD Sample/Sample Dup		27⁽³⁾	23⁽³⁾	NA	25⁽³⁾	13
ISO18-16-02-022	COIL-GW-PW-113-0-181003	29.0	1.26	5.28	2.04	26.2
ISO18-16-02-022-DUP	COIL-GW-PW-113-DB-181003	29.2	1.24	5.22	1.99	24.2
Average		29.1	1.25	5.25	2.02	25.2
%RPD Sample/Sample Dup		0.69	1.6	1.1	2.5	7.9
ISO18-16-02-023	COIL-GW-PW-37-0-181003	0.452	0.114	0.0674	0.216	1.51
ISO18-16-02-023-DUP	COIL-GW-PW-37-DB-181003	0.452	0.116	<0.0500	0.216	1.63
Average		0.452	0.115	0.0674	0.216	1.57
%RPD Sample/Sample Dup		0.0	1.7	NA	0.0	7.6
ISO18-16-02-024	COIL-GW-PW-91-0-181003	1.53	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-024-DUP	COIL-GW-PW-91-DB-181003	1.61	<0.0240	0.0580	<0.0250	<0.0232
Average		1.57	<0.0240	0.0580	<0.0250	<0.0232
%RPD Sample/Sample Dup		5.1	NA	NA	NA	NA
ISO18-16-02-025	COIL-GW-PW-94-0-181003	19.5	1.69	0.290	3.68	35.6
ISO18-16-02-025-DUP	COIL-GW-PW-94-DB-181003	19.0	1.66	0.308	3.62	34.0
Average		19.3	1.68	0.299	3.65	34.8
%RPD Sample/Sample Dup		2.6	1.8	6.0	1.6	4.6
ISO18-16-02-026	COIL-GW-Bldg 1 Coffee Sink-0-181003	8.62	0.384	1.32	0.680	8.18
ISO18-16-02-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB-181003	8.70	0.386	1.32	0.668	8.18
Average		8.66	0.385	1.32	0.674	8.18
%RPD Sample/Sample Dup		0.92	0.52	0.0	1.8	0.0

NA = Not Applicable

- (1) Sample set was analyzed by internal standard calibration, except where noted. The analytical data uncertainties associated with the reported results by internal standard calibration are as follows: PFBA ± 16%, PFOA ± 11%, PFBS ± 13%, PFHS ± 8.3% and PFOS ± 10%.
- (2) Sample set was analyzed by external standard calibration. The analytical data uncertainties associated with the reported results by external standard calibration is as follows: PFBA ± 13%.
- (3) The sample / sample duplicate RPD did not meet method acceptance criteria of ≤20%.

Table 1 continued. Sample Results Summary ⁽¹⁾

3M LIMS ID	Sample Description	PFBA Concentration (ng/mL)	PFOA Concentration (ng/mL)	PFBS Concentration (ng/mL)	PFHS Concentration (ng/mL)	PFOS Concentration (ng/mL)
Residential Wells						
ISO18-16-02-028	COIL-GW-22610-0-181002	0.386	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-028-DUP	COIL-GW-22610-DB-181002	0.390	<0.0240	<0.0500	<0.0250	<0.0232
Average		0.388	<0.0240	<0.0500	<0.0250	<0.0232
%RPD Sample/Sample Dup		1.0	NA	NA	NA	NA
ISO18-16-02-029	COIL-GW-22704-0-181002	1.65	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-029-DUP	COIL-GW-22704-DB-181002	1.72	<0.0240	<0.0500	<0.0250	<0.0232
Average		1.69	<0.0240	<0.0500	<0.0250	<0.0232
%RPD Sample/Sample Dup		4.2	NA	NA	NA	NA
ISO18-16-02-030	COIL-GW-22703-0-181002	0.908	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-030-DUP	COIL-GW-22703-DB-181002	0.928	<0.0240	<0.0500	<0.0250	<0.0232
Average		0.918	<0.0240	<0.0500	<0.0250	<0.0232
%RPD Sample/Sample Dup		2.2	NA	NA	NA	NA
ISO18-16-02-031	COIL-GW-22414-0-181002	0.968	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-031-DUP	COIL-GW-22414-DB-181002	0.930	<0.0240	<0.0500	<0.0250	<0.0232
Average		0.949	<0.0240	<0.0500	<0.0250	<0.0232
%RPD Sample/Sample Dup		4.0	NA	NA	NA	NA
ISO18-16-02-032	COIL-GW-22009-0-181002	1.86	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-032-DUP	COIL-GW-22009-DB-181002	2.00	<0.0240	<0.0500	<0.0250	<0.0232
Average		1.93	<0.0240	<0.0500	<0.0250	<0.0232
%RPD Sample/Sample Dup		7.3	NA	NA	NA	NA
ISO18-16-02-033	COIL-GW-21421-0-181002	2.04	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-033-DUP	COIL-GW-21421-DB-181002	2.08	<0.0240	<0.0500	<0.0250	<0.0232
Average		2.06	<0.0240	<0.0500	<0.0250	<0.0232
%RPD Sample/Sample Dup		1.9	NA	NA	NA	NA
ISO18-16-02-034	COIL-GW-TRIP-0-180927	<0.100	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-035	COIL-GW-RB01-MW-5-79-0-181001	<0.100	<0.0240	<0.0500	<0.0250	<0.0232
ISO18-16-02-036	COIL-GW -RB02-MW-3-94-0-181002	<0.100	<0.0240	<0.0500	<0.0250	<0.0232

NA = Not Applicable

- (1) Sample set was analyzed by internal standard calibration, except where noted. The analytical data uncertainties associated with the reported results by internal standard calibration are as follows: PFBA ± 16%, PFOA ± 11%, PFBS ± 13%, PFHS ± 8.3% and PFOS ± 10%.
- (2) Sample set was analyzed by external standard calibration. The analytical data uncertainties associated with the reported results by external standard calibration is as follows: PFBA ± 13%.
- (3) The sample / sample duplicate RPD did not meet method acceptance criteria of ≤20%.

2 Methods - Analytical and Preparatory

2.1 Methods

Analysis was completed following 3M EHS Laboratory method ETS-8-044.3 "Method of Analysis for the Determination of Perfluorinated Compounds in Water by LC/MS/MS; Direct Injection Analysis".

Table 2. Target Analytes

Target Analytes	Acronym	Reference Material Structure
Perfluorobutanoic Acid (C4 Acid)	PFBA	Linear
Perfluoroctanoic Acid (C8 Acid)	PFOA	Linear + Branched
Perfluorobutanesulfonate (C4 Sulfonate)	PFBS	Linear
Perfluorohexanesulfonate (C6 Sulfonate)	PFHS	Linear
Perfluorooctanesulfonate (C8 Sulfonate)	PFOS	Linear + Branched

2.2 Sample Collection

Samples were collected October 1-3, 2018 in Nalgene™ (high-density polyethylene) bottles prepared at the 3M EHS Laboratory. Prior to sample collection, bottles designated for field matrix spikes were spiked in the laboratory with a known volume of an appropriate matrix spiking solution containing the analytes of interest. Collected sample bottles were returned to the laboratory on ice on October 4, 2018.

2.3 Sample Preparation

Samples analyzed by internal standard calibration were prepared by removing a 0.4 mL aliquot of the well mixed sample and diluting it with 0.4 mL of methanol (dilution factor of 2). During the preparation of the laboratory control samples, an aliquot of a separate internal standard spiking solution was added to the laboratory control samples (nominal concentration of 1 ng/mL). The sample bottles were spiked with an internal standard mix at a nominal concentration of 1 ng/mL prior to being sent to the field for sample collection. The laboratory control samples were then diluted in the same manner as the samples.

Sample sets COIL-GW-MW-3-94 (ISO18-16-02-012) and COIL-GW-MW-4-81 (ISO18-16-02-018) were analyzed for PFBA by external standard calibration and required further dilution prior to analysis. Samples were prepared by diluting 1.0 mL of well-mixed sample with 9.0 mL of methanol (dilution factor of 10). Diluted samples were fortified with 0.01 mL of a solution containing surrogate recovery standard (SRS) [¹³C₃]-PFBA (SRS spiked at a nominal concentration of 1 ng/mL). The laboratory control samples were prepared and analyzed in the same manner as the 500-fold diluted samples. Prepared samples were analyzed by external standard calibration.

2.4 Analysis

All samples and quality control samples were analyzed for five target analytes using high performance liquid chromatography/tandem mass spectrometry (HPLC/MS/MS). Pertinent instrument parameters, the liquid chromatography gradient program, and the specific mass transitions analyzed are described in the tables below.

Due to the nature of the sample, the wide range of concentrations found in the sample, and the environmental occurrence of multiple isomers of the laboratory's analytes of interest, the software used for processing the analytical results is not able to consistently integrate the analytical peak, manual integration of the analytical peak is necessary. All manual integrations are performed following the procedures outlined in method ETS-12-010.2. The consistency of the laboratory's integration is ensured through the training of laboratory personnel, the peer review process required for all manual

integrations, the review of manual integrations by the QAU, and where necessary the review of manual integrations by laboratory management.

Table 3. Instrument Parameters.

Instrument Name	ETS Tesla	ETS Rita
Liquid Chromatograph	Agilent 1260	Agilent 1260
Analysis Method	ETS-8-044.3	ETS-8-044.3
Analysis Date	10/23/18	10/28/18, 11/2/18, 11/6/18
Guard column	Prism RP (2.1 mm X 50 mm), 5 μ	Prism RP (2.1 mm X 50 mm), 5 μ
Analytical column	Betasil C18 (2.1 mm X 100 mm), 5 μ	Betasil C18 (2.1 mm X 100 mm), 5 μ
Injection Volume	10 μ L	5 μ L
Mass Spectrometer	AB Sciex Triple Quad 6500+	AB Sciex Triple Quad 6500+
Ion Source	Turbo Spray	Turbo Spray
Polarity	Negative	Negative
Software	Analyst 1.6.3	Analyst 1.6.3

Table 4. Liquid Chromatography Gradient Program.

Step Number	Total Time (min)	Flow Rate (μ L/min)	Percent A (2 mM ammonium acetate)	Percent B (Methanol)
ETS-8-044.3				
0	0.00	300	90.0	10.0
1	0.50	300	90.0	10.0
2	0.70	300	60.0	40.0
3	9.00	300	5.0	95.0
4	11.0	300	5.0	95.0
5	12.0	300	90.0	10.0
6	14.0	300	90.0	10.0

Table 5. Liquid Chromatography Gradient Program.

Analyte	Mass Transition Q1/Q3	Internal Standard	Mass Transition Q1/Q3
PFBA	213/169	[¹³ C ₄]-PFBA ⁽¹⁾	217/172
PFOA	413/369	[¹³ C ₈]-PFOA	421/376
	413/219		
	413/169		
PFBS	299/80	[¹⁸ O ₂]-PFBS	303/84
	299/99		
PFHS	399/99	[¹³ C ₃]-PFHS	402/80
	399/80		
PFOS	499/99	[¹³ C ₈]-PFOS	507/80
	499/80		
	499/130		
[¹³ C ₃]-PFBA	216/172	[¹³ C ₄]-PFBA	217/172
[¹³ C ₈]-PFOA	417/372	[¹³ C ₈]-PFOA	421/376
[¹³ C ₈]-PFOS	503/80	[¹³ C ₈]-PFOS	507/80

The individual transitions were summed to produce a "total ion chromatogram" (TIC), which was used for quantitation.

(1) Internal standard was not used for the analysis on 11/2/18.

3 Data Analysis

3.1 Calibration

Solvent dilution analysis using internal standard calibration: Samples were analyzed against a matrix-matched stable isotope internal standard calibration curve. Calibration standards were prepared by spiking known amounts of stock solutions into 50 mL of 50:50 methanol:laboratory reagent water. The calibration standards contained an internal standard mix at a nominal concentration of 0.5 ng/mL. Calibration standards ranging from 0.0125 ng/mL to 100 ng/mL (nominal) were analyzed on 10/23/18 and 10/28/18. Calibration standards ranging from 0.0125 ng/mL to 2.5 ng/mL (nominal) were analyzed on 11/6/18. The standards also contained the surrogates at concentrations ranging from 0.0125 ng/mL to 10 ng/mL (nominal). A quadratic, 1/x weighted, calibration curve of the ratio of the standard peak area counts over the internal standard peak area counts was used to fit the data for each analyte. The data were not forced through zero during the fitting process. Calculating the standard concentrations using the peak area ratios and the resultant calibration curve confirmed accuracy of each curve point.

Solvent dilution analysis using external standard calibration: Samples were analyzed against an external standard calibration curve. Calibration standards were prepared by spiking known amounts of the stock solution into 50 mL of 90:10 methanol: laboratory Milli-Q™ water. Calibration standards ranging from 0.1 ng/mL to 50 ng/mL (nominal) were analyzed. A quadratic, 1/x weighted, calibration curve of the standard peak area counts was used to fit the data for each analyte. The data were not forced through zero during the fitting process. Calculating the standard concentrations using the peak area counts and the resultant calibration curve confirmed accuracy of each curve point.

For both methods of analysis, each curve point was quantitated using the overall calibration curve and reviewed for accuracy. Method calibration accuracy requirements of 100±25% (100±30% for the lowest curve point) were met for all analytes. The correlation coefficient (*r*) was greater than 0.998 for all analytes.

3.2 System Suitability

A calibration standard was analyzed four times at the beginning of the analytical sequence to demonstrate overall system suitability. The acceptance criteria for system suitability samples of less than or equal to 5% relative standard deviation (RSD) for peak area counts or peak area ratio and retention time criteria of less than or equal to 2% RSD were met for each analysis for all analytes.

3.3 Limit of Quantitation (LOQ)

The LOQ as defined in method ETS-8-044.3 is the lowest non-zero calibration standard in the curve that meets linearity and accuracy requirements and for which the area counts are at least twice those of the appropriate blanks. The LOQs associated with the sample analysis are listed in the Table 6 below.

Table 6. LOQ

Analyte	LOQ, ng/mL ⁽¹⁾ 10/23/18 Internal Calibration	LOQ, ng/mL ⁽¹⁾ 10/28/18 Internal Calibration	LOQ, ng/mL ⁽²⁾ 11/2/18 External Calibration	LOQ, ng/mL ⁽¹⁾ 11/6/18 Internal Calibration
PFBA	0.100	NA	1.00	NA
PFOA	0.0240	NA	NA	NA
PFBS	0.0500	0.0500	NA	0.0500
PFHS	NA	0.0250	NA	NA
PFOS	0.0232	0.0232	NA	NA

NA = Not Applicable

(1) A dilution factor of 2 applied to the LOQ.

(2) A dilution factor of 10 applied to the LOQ.

3.4 Continuing Calibration

During the course of the analytical sequence, several continuing calibration verification samples (CCVs) were analyzed to confirm that the instrument response and the initial calibration curve were still in control. All reported results were bracketed by CCVs that met method acceptance criteria of 100%±25%.

3.5 Blanks

Three types of blanks were prepared and analyzed with the samples: method/solvent blanks, field/trip blanks, and sampling equipment blanks. Each blank result was reviewed and used to evaluate method performance. The method/solvent blanks were used to determine the LOQ for each analyte.

3.6 Lab Control Spikes (LCSs)

Low, mid, and high lab control spikes were prepared for the target analytes and analyzed in triplicate. LCSs prepared for internal standard calibration analysis were prepared by spiking known amounts of the analytes into 10 mL of laboratory reagent water to produce the desired concentration. LCSs analyzed on 10/23/18 and 10/28/18 were prepared at nominal concentration of 0.2 ng/mL, 40 ng/mL, and 140 ng/mL. LCSs analyzed on 11/2/18 were prepared at 10 ng/mL, 100 ng/mL and 398 ng/mL. LCSs analyzed on 11/6/18 were prepared at nominal concentrations of 0.1 ng/mL, 1 ng/mL and 4 ng/mL. The LCSs were then diluted in the same manner as the samples. Method ETS-8-044.3 states that the average recovery of LCSs at each spiking level must be within 80%-120% with a RSD ≤20%. All LCS samples met these criteria.

The batch LCS recovery results were reviewed when evaluating the analytical method uncertainty in section 3.7 of the report. Individual LCS results are included in the raw data and available upon request.

3.7 Analytical Data Uncertainty

Analytical uncertainty is based on historical QC data that is control charted and used to evaluate method accuracy and precision. The method uncertainty is calculated following ETS-12-012.4. The standard deviation is calculated for the set of accuracy results (in %) obtained for the QC samples. For method ETS-8-044.3, the most recent fifty QC samples were used. The expanded uncertainty is calculated by multiplying the standard deviation by a factor of 2, which corresponds to a confidence level of 95%.

Table 7. Analytical Data Uncertainty.

Analyte	Calibration	Standard Deviation (%)	Method Uncertainty
PFBA	External	6.43	±13%
PFBA	Internal	8.04	±16%
PFOA	Internal	5.56	±11%
PFBS	Internal	6.67	±13%
PFHS	Internal	4.13	±8.3%
PFOS	Internal	5.22	±10%

3.8 Field Matrix Spikes (FMS)

A target analyte field matrix spike sample was collected at select sampling points to verify that the analytical method is applicable for the collected matrix. Field matrix spikes are generated by adding a measured volume of field sample to a container spiked by the laboratory with the target analytes prior to shipping sample containers for sample collection. Field matrix spikes must be at least 50% of the analyte concentration to be considered an appropriate spike level. Field matrix spike recoveries within method acceptance criteria of 100±30% confirm that “unknown” components in the sample matrix do not significantly interfere with the preparation and analysis of the analytes of interest. The standards used for the preparation of the field matrix spiking solutions contained reference materials comprised of both linear and branched isomers for PFOS and PFOA. Field matrix spikes are presented in section 4 of this report.

In addition to target analyte field matrix spikes, a few of the samples contained stable isotope surrogate recovery spikes of [¹³C₃]-PFBA, [¹³C₄]-PFOA, and [¹³C₄]-PFOS, which were added at a nominal concentration of 0.1 ng/mL to select sample bottles prior to sample collection or at a nominal concentration of 1 ng/mL following sample collection. The [¹³C₃]-PFBA and [¹³C₄]-PFOA were selected to represent perfluorocarboxylic acids. The [¹³C₄]-PFOS was selected to represent the perfluorosulfonic acids. Surrogate matrix spike recoveries within method acceptance criteria of 100±30% confirm that “unknown” components in the sample matrix do not significantly interfere with the preparation and analysis of the analytes of interest. The surrogate spike recoveries are included in section 4 of this report.

$$FMS\ Recovery = \frac{Sample\ Conc.\ of\ FMS - Average\ Conc.\ (Field\ Sample\ & Field\ Sample\ Dup)}{Spike\ Conc.} \times 100\%$$

Table 8. Field Matrix Spike Concentrations

Location	Final Concentration (ng/mL)				
	PFBA	PFBS	PFHS	PFOA	PFOS
MW-4-79, MW-1-88, 22704, 21421	0.250	0.250	0.250	0.250	0.250
MW-7-94	5.00	5.00	5.00	5.00	5.00
MW-4-81, PW-113, PW-94	25.0	25.0	25.0	25.0	25.0
Trip Blank	0.250	0.250	0.250	0.250	0.250

4 Data Summary and Discussion

Tables 9-17 below summarize the sample results and field matrix spike (or lab matrix spike) recoveries for sampling locations as well as the Trip Blank. Each table provides the average concentration and the relative percent difference (%RPD) of the sample and sample duplicate. Results and average values are rounded to three significant figures. Percent relative difference (%RPD) values are rounded to two significant figures. Because of rounding, values vary slightly from those listed in the raw data. Field matrix spikes meeting the method acceptance criteria of $\pm 30\%$, demonstrate that the method is appropriate for the given matrix. **Table 18** summarizes the results for the surrogate recovery standards analyzed with each analytical batch.

The method indicates that the target analyte FMS samples should be spiked at approximately 0.5-10 times the expected analyte concentration in the sample. The field matrix spike concentration was selected based on the expected concentration of PFOA and/or PFOS, based on previous results for the Cottage Grove site. In instances where the FMS spike level is >10 times the endogenous amounts, the FMS recovery is reported and flagged as above 10 times the sample concentration.

For those analytes where the field matrix spike level was not appropriate as compared to the sample concentration, the surrogate recovery standards were used to assess method accuracy. All surrogate recovery standards for each sample set and field matrix spike recoveries met method acceptance criteria.

Table 9. COIL-GW-MW-4-79 181001

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-003	COIL-GW-MW-4-79-0-181001	0.392	NA	<0.0240	NA
ISO18-16-02-003-DUP	COIL-GW-MW-4-79-DB-181001	0.374	NA	<0.0240	NA
ISO18-16-02-003-FMS	COIL-GW-MW-4-79-FMS-181001	0.636	101	0.224	89.6
Average Concentration (ng/mL) ± %RPD		0.383 ng/mL ± 4.7%		<0.0240 ng/mL	
3M LIMS ID	Description	PFBS		PFHs	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-003	COIL-GW-MW-4-79-0-181001	<0.0500	NA	<0.0250	NA
ISO18-16-02-003-DUP	COIL-GW-MW-4-79-DB-181001	<0.0500	NA	<0.0250	NA
ISO18-16-02-003-FMS	COIL-GW-MW-4-79-FMS-181001	0.286	114	0.234	93.6
Average Concentration (ng/mL) ± %RPD		<0.0500 ng/mL		<0.0250 ng/mL	
				0.0341 ng/mL ± 26%⁽¹⁾	

NA = Not Applicable

(1) The sample / sample duplicate did not meet method acceptance criteria of ≤20%.

Table 10. COIL-GW-MW-1-88 181002

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-007	COIL-GW-MW-1-88-0-181002	16.1	NA	0.418	NA
ISO18-16-02-007-DUP	COIL-GW-MW-1-88-DB-181002	16.3	NA	0.414	NA
ISO18-16-02-007-FMS	COIL-GW-MW-1-88-FMS-181002	16.4	NC	0.676	104
Average Concentration (ng/mL) ± %RPD		16.2 ng/mL ± 1.2%		0.416 ng/mL ± 0.96%	
3M LIMS ID	Description	PFBS		PFHs	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-005	COIL-GW-MW-1-81-0-180423	1.63	NA	0.704	NA
ISO18-16-02-005-DUP	COIL-GW-MW-1-81-DB-180423	1.63	NA	0.696	NA
ISO18-16-02-005-FMS	COIL-GW-MW-1-81-FMS-180423	2.04	NC	0.924	NC
Average Concentration (ng/mL) ± %RPD		1.63 ng/mL ± 0.0%		0.700 ng/mL ± 1.1%	
				2.70 ng/mL ± 4.4%	

NA = Not Applicable
NC = Not Calculated; Spike level was less than 0.5 times the endogenous sample concentration.

Table 11. COIL-GW-MW-7-94 181002

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-014	COIL-GW-MW-7-94-0-181002	27.6	NA	0.912	NA
ISO18-16-02-014-DUP	COIL-GW-MW-7-94-DB-181002	27.4	NA	0.892	NA
ISO18-16-02-014-FMS	COIL-GW-MW-7-94-FMS-181002	31.6	NC	5.24	86.8
Average Concentration (ng/mL) ± %RPD		27.5 ng/mL ± 0.73%		0.902 ng/mL ± 2.2%	

3M LIMS ID	Description	PFBS		PFHxS		PFOS	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-009	COIL-GW-MW-7-90-0-180424	2.10	NA	2.38	NA	10.5	NA
ISO18-16-02-009-DUP	COIL-GW-MW-7-90-DB-180424	2.10	NA	2.42	NA	10.5	NA
ISO18-16-02-009-FMS	COIL-GW-MW-7-90-FMS-180424	7.28	104	7.06	93.2	14.9	NC
Average Concentration (ng/mL) ± %RPD		2.10 ng/mL ± 0.0%		2.40 ng/mL ± 1.7%		10.5 ng/mL ± 0.0%	

NA = Not Applicable

NC = Not Calculated; Spike level was less than 0.5 times the endogenous sample concentration.

Table 12. COIL-GW-MW-4-81 181001

		PFBA		PFOA	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-018	COIL-GW-MW-4-81-0-181001	220	NA	2.64	NA
ISO18-16-02-018-DUP	COIL-GW-MW-4-81-DB-181001	232	NA	2.64	NA
ISO18-16-02-018-FMS	COIL-GW-MW-4-81-FMS-181001	252	NC	26.2	94.2
Average Concentration (ng/mL) ± %RPD		226 ng/mL ± 5.3%		2.64 ng/mL ± 0.0%	
		PFBS		PFHs	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-018	COIL-GW-MW-4-81-0-181001	7.34	NA	5.68	NA
ISO18-16-02-018-DUP	COIL-GW-MW-4-81-DB-181001	7.62	NA	5.92	NA
ISO18-16-02-018-FMS	COIL-GW-MW-4-81-FMS-181001	33.4	104	29.4	94.4
Average Concentration (ng/mL) ± %RPD		7.48 ng/mL ± 3.7%		5.80 ng/mL ± 4.1%	
		PFOS		PFOS	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-018	COIL-GW-MW-4-81-0-181001	7.34	NA	24.6	NA
ISO18-16-02-018-DUP	COIL-GW-MW-4-81-DB-181001	7.62	NA	23.8	NA
ISO18-16-02-018-FMS	COIL-GW-MW-4-81-FMS-181001	33.4	104	46.0	87.2
Average Concentration (ng/mL) ± %RPD		7.48 ng/mL ± 3.7%		24.2 ng/mL ± 3.3%	

NA = Not Applicable
NC = Not Calculated; Spike level was less than 0.5 times the endogenous sample concentration.

Table 13. COIL-GW-PW-113 181003

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-022	COIL-GW-PW-113-0-181003	29.0	NA	1.26	NA
ISO18-16-02-022-DUP	COIL-GW-PW-113-DB-181003	29.2	NA	1.24	NA
ISO18-16-02-022-FMS	COIL-GW-PW-113-FMS-181003	54.8	103	23.4 ⁽¹⁾	88.6
Average Concentration (ng/mL) ± %RPD		29.1 ng/mL ± 0.69%		1.25 ng/mL ± 1.6%	
3M LIMS ID	Description	PFBS		PFHs	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-022	COIL-GW-PW-113-0-181003	5.28	NA	2.04	NA
ISO18-16-02-022-DUP	COIL-GW-PW-113-DB-181003	5.22	NA	1.99	NA
ISO18-16-02-022-FMS	COIL-GW-PW-113-FMS-181003	31.4	105	25.2 ⁽¹⁾	92.7
Average Concentration (ng/mL) ± %RPD		5.25 ng/mL ± 1.1%		2.02 ng/mL ± 2.5%	25.2 ng/mL ± 7.9%

NA = Not Applicable

(1) FMS spike level was greater than 10x the endogenous sample concentration.

Table 14. COIL-GW-PW-94 181003

		PFBA		PFOA	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-025	COIL-GW-PW-94-0-181003	19.5	NA	1.69	NA
ISO18-16-02-025-DUP	COIL-GW-PW-94-DB-181003	19.0	NA	1.66	NA
ISO18-16-02-025-FMS	COIL-GW-PW-94-FMS-181003	44.6	101	23.4 ⁽¹⁾	86.9
Average Concentration (ng/mL) ± %RPD		19.3 ng/mL ± 2.6%		1.68 ng/mL ± 1.8%	
		PFBS	PFHS		
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-021	COIL-GW-PW-112-0-180425	0.290	NA	3.68	NA
ISO18-16-02-021-DUP	COIL-GW-PW-112-DB-180425	0.308	NA	3.62	NA
ISO18-16-02-021-FMS	COIL-GW-PW-112-FMS-180425	26.2 ⁽¹⁾	104	27.0	93.4
Average Concentration (ng/mL) ± %RPD		0.299 ng/mL ± 6.0%		3.65 ng/mL ± 1.6%	
			PFOS		
			Concentration (ng/mL)	%Recovery	
			35.6	NA	
			34.0	NA	
			61.0	105	
			34.8 ng/mL ± 4.6%		

NA = Not Applicable

(1) FMS spike level was greater than 10x the endogenous sample concentration.

Table 15. COIL-GW-22704 181002

		PFBA		PFOA	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-029	COIL-GW-22704-0-181002	1.65	NA	<0.0240	NA
ISO18-16-02-029-DUP	COIL-GW-22704-DB-181002	1.72	NA	<0.0240	NA
ISO18-16-02-029-FMS	COIL-GW-22704-FMS- 181002	2.16	NC	0.218	87.2
Average Concentration (ng/mL) ± %RPD		1.69 ng/mL ± 4.2%		<0.0240 ng/mL	

		PFBS		PFHS		PFOS	
3M LIMS ID	Description	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-026	COIL-GW-Bldg 1 Coffee Sink-0-180425	<0.0500	NA	<0.0250	NA	<0.0232	NA
ISO18-16-02-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB-180425	<0.0500	NA	<0.0250	NA	<0.0232	NA
ISO18-16-02-026-FMS	COIL-GW-Bldg 1 Coffee Sink-FMS-180425	0.318	127	0.236	94.4	0.212	84.8
Average Concentration (ng/mL) ± %RPD		<0.0500 ng/mL		<0.0250 ng/mL		<0.0232 ng/mL	

NA = Not Applicable

Table 16. COIL-GW-21421 181002

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-033	COIL-GW-21421-0-181002	2.04	NA	<0.0240	NA
ISO18-16-02-033-DUP	COIL-GW-21421-DB-181002	2.08	NA	<0.0240	NA
ISO18-16-02-033-FMS	COIL-GW-21421-FMS- 181002	2.32	NC	0.216	86.4
Average Concentration (ng/mL) ± %RPD		2.06 ng/mL ± 1.9%		<0.0240 ng/mL	

3M LIMS ID	Description	PFBS		PFOS	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-026	COIL-GW-Bldg 1 Coffee Sink-0-180425	<0.0500	NA	<0.0250	NA
ISO18-16-02-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB-180425	<0.0500	NA	<0.0250	NA
ISO18-16-02-026-FMS	COIL-GW-Bldg 1 Coffee Sink-FMS-180425	0.286	114	0.222	88.8
Average Concentration (ng/mL) ± %RPD		<0.0500 ng/mL		<0.0250 ng/mL	<0.0232 ng/mL

NA = Not Applicable

Table 17. CGMM GW Trip Blank (1)

3M LIMS ID	Description	PFBA		PFOA	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-034	COIL-GW-TRIP-0- 180927	<0.100	NA	<0.0240	NA
ISO18-16-02-034-FMS	COIL-GW-TRIP-FMS- 180927	0.258	103	0.214	85.6

NA = Not Applicable

3M LIMS ID	Description	PFBS		PFOS	
		Concentration (ng/mL)	%Recovery	Concentration (ng/mL)	%Recovery
ISO18-16-02-034	COIL-GW-TRIP-0- 180927	<0.0500	NA	<0.0250	NA
ISO18-16-02-034-FMS	COIL-GW-TRIP-FMS- 180927	0.260	104	0.224	89.6

Table 18. Surrogate Recovery Standard Results⁽¹⁾

3M LIMS ID	Sample Description	Percent Recovery (%)			
		Analyzed 10/23/18		Analyzed 10/28/18	
		[¹³ C ₃]-PFBA	[¹³ C ₄]-PFOA	[¹³ C ₄]-PFOS	[¹³ C ₄]-PFOS
ISO18-16-02-001	COIL-GW-MW-1-79-0-181003	88.4	78.6	89.6	89.6
ISO18-16-02-001-DUP	COIL-GW-MW-1-79-DB-181003	86.4	83.4	88.8	87.1
ISO18-16-02-002	COIL-GW-MW-3-79-0-181001	86.0	76.8	88.2	87.3
ISO18-16-02-002-DUP	COIL-GW-MW-3-79-DB-181001	83.4	81.4	88.4	90.5
ISO18-16-02-003	COIL-GW-MW-4-79-0-181001	84.8	74.4	86.1	89.6
ISO18-16-02-003-DUP	COIL-GW-MW-4-79-DB-181001	83.4	79.2	90.3	90.9
ISO18-16-02-003-FMS	COIL-GW-MW-4-79-FMS-181001	86.4	80.4	90.1	88.4
ISO18-16-02-004	COIL-GW-MW-5-79-0-181001	86.2	83.6	85.2	87.7
ISO18-16-02-004-DUP	COIL-GW-MW-5-79-DB-181001	82.0	74.8	88.0	89.2
ISO18-16-02-005	COIL-GW-MW-1-81-0-181002	86.4	83.2	89.8	91.1
ISO18-16-02-005-DUP	COIL-GW-MW-1-81-0-DB-181002	85.4	79.6	89.4	91.3
ISO18-16-02-006	COIL-GW-MW-3-81-0-181001	84.4	84.6	88.6	89.8
ISO18-16-02-006-DUP	COIL-GW-MW-3-81-0-DB-181001	84.8	76.4	84.4	88.4
ISO18-16-02-007	COIL-GW-MW-1-88-0-181002	85.8	79.8	87.1	88.2
ISO18-16-02-007-DUP	COIL-GW-MW-1-88-DB-181002	86.2	81.2	89.0	91.9
ISO18-16-02-007-FMS	COIL-GW-MW-1-88-FMS-181002	87.6	79.4	88.4	86.9
ISO18-16-02-008	COIL-GW-MW-2-90-0-181002	86.0	76.4	88.6	91.1
ISO18-16-02-008-DUP	COIL-GW-MW-2-90-DB-181002	87.6	77.6	87.5	87.7
ISO18-16-02-009	COIL-GW-MW-7-90-0-181002	85.6	86.2	87.3	93.0
ISO18-16-02-009-DUP	COIL-GW-MW-7-90-DB-181002	84.8	87.6	91.1	88.6
ISO18-16-02-010	COIL-GW-MW-9-90R-0-181002	86.0	80.6	89.8	86.5
ISO18-16-02-010-DUP	COIL-GW-MW-9-90R-DB-181002	82.8	82.0	85.9	85.4
ISO18-16-02-011	COIL-GW-MW-1-93-0-181002	82.6	82.6	89.0	87.1
ISO18-16-02-011-DUP	COIL-GW-MW-1-93-DB-181002	85.4	79.6	86.7	87.5
ISO18-16-02-012	COIL-GW-MW-3-94-0-181002	80.8	82.8	90.1	88.6
ISO18-16-02-012-DUP	COIL-GW-MW-3-94-DB-181002	84.8	83.6	87.5	88.4
ISO18-16-02-013	COIL-GW-MW-4-94-0-181002	85.2	85.2	87.7	88.0
ISO18-16-02-013-DUP	COIL-GW-MW-4-94-DB-181002	86.4	79.8	84.0	83.1
ISO18-16-02-014	COIL-GW-MW-7-94-0-181002	84.2	79.4	85.9	88.2
ISO18-16-02-014-DUP	COIL-GW-MW-7-94-DB-181002	83.6	78.0	87.1	88.8
ISO18-16-02-014-FMS	COIL-GW-MW-7-94-FMS-181002	85.2	81.4	88.4	88.2
ISO18-16-02-015	COIL-GW-MW-8-94-0-181001	84.6	81.6	88.6	88.0
ISO18-16-02-015-DUP	COIL-GW-MW-8-94-DB-181001	86.4	83.2	90.7	90.7
ISO18-16-02-016	COIL-GW-MW-9-94-0-181001	87.2	84.2	88.6	89.2
ISO18-16-02-016-DUP	COIL-GW-MW-9-94-DB-181001	84.0	77.6	89.4	90.1
ISO18-16-02-017	COIL-GW-MW-2-81-0-181001	85.0	81.6	88.2	89.0
ISO18-16-02-017-DUP	COIL-GW-MW-2-81-DB-181001	85.4	84.8	86.1	88.6
ISO18-16-02-018	COIL-GW-MW-4-81-0-181001	78.4	79.8	89.4	88.0
ISO18-16-02-018-DUP	COIL-GW-MW-4-81-DB-181001	84.0	82.0	86.5	89.4
ISO18-16-02-018-FMS	COIL-GW-MW-4-81-FMS-181001	85.2	86.0	89.6	89.6
ISO18-16-02-019	COIL-GW-MW-5-81-0-181001	85.4	79.6	90.1	88.4
ISO18-16-02-019-DUP	COIL-GW-MW-5-81-DB-181001	85.2	81.2	90.3	84.8

(1) Reported by internal standard calibration unless noted otherwise.

(2) Reported by external standard calibration. Additional surrogate added during sample preparation.

Table 18 continued. Surrogate Recovery Standard Results ⁽¹⁾

3M LIMS ID	Sample Description	Percent Recovery (%)			
		Analyzed 10/23/18		Analyzed 10/28/18	
		[¹³ C ₃]-PFBA	[¹³ C ₄]-PFOA	[¹³ C ₄]-PFOS	[¹³ C ₄]-PFOS
ISO18-16-02-020	COIL-GW-PW-11-0-181003	86.0	82.6	89.6	85.4
ISO18-16-02-020-DUP	COIL-GW-PW-11-DB-181003	85.2	86.2	89.2	88.4
ISO18-16-02-021	COIL-GW-PW-112-0-181003	88.2	84.0	89.8	91.3
ISO18-16-02-021-DUP	COIL-GW-PW-112-DB-181003	84.6	74.4	84.2	85.7
ISO18-16-02-022	COIL-GW-PW-113-0-181003	83.4	86.6	90.3	88.2
ISO18-16-02-022-DUP	COIL-GW-PW-113-DB-181003	85.2	82.2	89.2	86.5
ISO18-16-02-022-FMS	COIL-GW-PW-113-FMS-181003	85.8	82.0	88.6	92.6
ISO18-16-02-023	COIL-GW-PW-37-0-181003	87.4	84.6	92.6	88.2
ISO18-16-02-023-DUP	COIL-GW-PW-37-DB-181003	84.2	84.0	86.5	89.6
ISO18-16-02-024	COIL-GW-PW-91-0-181003	85.2	83.8	87.7	89.8
ISO18-16-02-024-DUP	COIL-GW-PW-91-DB-181003	87.2	81.8	91.3	90.3
ISO18-16-02-025	COIL-GW-PW-94-0-181003	87.0	82.4	87.5	86.9
ISO18-16-02-025-DUP	COIL-GW-PW-94-DB-181003	86.0	84.8	88.4	93.4
ISO18-16-02-025-FMS	COIL-GW-PW-94-FMS-181003	83.4	73.6	90.9	87.3
ISO18-16-02-026	COIL-GW-Bldg 1 Coffee Sink-0-181003	83.2	76.2	87.5	91.9
ISO18-16-02-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB-181003	84.2	78.4	88.6	88.8
ISO18-16-02-028	COIL-GW-22610-0-181002	85.0	87.4	88.8	88.8
ISO18-16-02-028-DUP	COIL-GW-22610-DB-181002	86.2	82.0	90.9	92.4
ISO18-16-02-029	COIL-GW-22704-0-181002	86.8	80.4	86.1	85.4
ISO18-16-02-029-DUP	COIL-GW-22704-DB-181002	85.6	73.4	89.0	91.3
ISO18-16-02-029-FMS	COIL-GW-22704-FMS- 181002	85.0	82.4	85.7	88.6
ISO18-16-02-030	COIL-GW-22703-0-181002	84.6	79.4	90.9	91.1
ISO18-16-02-030-DUP	COIL-GW-22703-DB-181002	84.6	76.8	87.3	89.0
ISO18-16-02-031	COIL-GW-22414-0-181002	84.8	86.4	89.8	85.9
ISO18-16-02-031-DUP	COIL-GW-22414-DB-181002	86.0	81.8	88.4	86.7
ISO18-16-02-032	COIL-GW-22009-0-181002	85.8	83.8	89.6	91.1
ISO18-16-02-032-DUP	COIL-GW-22009-DB-181002	88.8	82.8	88.0	88.4
ISO18-16-02-033	COIL-GW-21421-0-181002	87.6	80.2	88.6	91.5
ISO18-16-02-033-DUP	COIL-GW-21421-DB-181002	87.8	81.8	87.1	87.7
ISO18-16-02-033-FMS	COIL-GW-21421-FMS- 181002	87.6	84.6	87.5	91.1
ISO18-16-02-034	COIL-GW-TRIP-0-180927	85.6	84.6	89.4	89.8
ISO18-16-02-034-FMS	COIL-GW-TRIP-FMS-180927	87.0	81.6	89.0	92.1
ISO18-16-02-035	COIL-GW-RB01-MW-5-79-0-181001	88.6	85.4	87.1	89.6
ISO18-16-02-036	COIL-GW -RB02-MW-3-94-0-181002	85.4	77.4	88.2	91.3

3M LIMS ID	Sample Description	Analyzed 11/2/18 ⁽²⁾	
		Percent Recovery (%)	
		[¹³ C ₃]-PFBA	[¹³ C ₄]-PFOA
ISO18-16-02-012	COIL-GW-MW-3-94-0-181002	98.7	
ISO18-16-02-012-DUP	COIL-GW-MW-3-94-DB-181002	96.2	
ISO18-16-02-018	COIL-GW-MW-4-81-0-181001	95.8	
ISO18-16-02-018-DUP	COIL-GW-MW-4-81-DB-181001	94.0	

(1) Reported by internal standard calibration unless noted otherwise.

(2) Reported by external standard calibration. Additional surrogate added during sample preparation.

5 Conclusion

Laboratory control spikes were used to determine the analytical method accuracy and precision for all analytes. The accuracy and precision were then used to estimate the method uncertainty for the results. Field matrix spike recoveries demonstrated that the analytical method was appropriate for the given sample matrix except where noted. Analysis was completed using 3M EHS Laboratory method ETS-8-044.3 "Method of Analysis for the Determination of Perfluorinated Compounds in Water by LC/MS/MS; Direct Injection Analysis". Analytical results are reported in Tables 1 and 9-18 of this report.

6 Data / Sample Retention

All remaining sample and associated project data (hardcopy and electronic) will be archived according to 3M EHS Laboratory standard operating procedures.

7 Attachments

Attachment A: Historical Trend Chart
Attachment B: Chain of Custody Form

8 Signatures

Susan T. Wolf, 3M Principal Analytical Investigator and Report Author

Brian T. Mader, Ph.D., 3M EHS Laboratory Manager

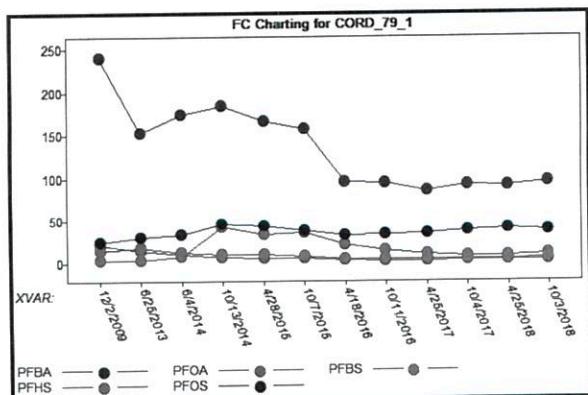
The 3M EHS Laboratory's Quality Assurance Unit has audited the data and report for this project.

Quality Assurance Representative

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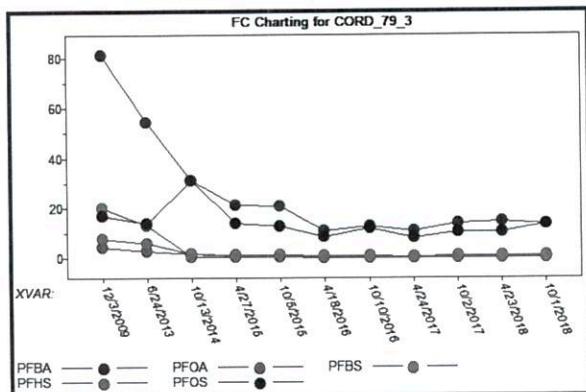
Attachment A: Historical Trend Chart

MW-1-79



MW-1-79	12/2/09	6/25/13	8/4/13	10/13/14	4/28/15	10/7/15	4/18/16	10/11/16	4/25/17	10/4/17	4/25/18	10/3/18
PFBA	240	152	174	184	166	157	94.7	93.9	84.4	91.7	90.3	94.6
PFOA	21.0	14.0	9.52	6.24	5.34	4.85	2.68	1.93	1.91	2.73	2.50	2.46
PFBS	2.57	2.89	6.80	41.8	33.7	35.3	20.9	14.0	9.49	7.55	7.85	9.12
PFHS	14.3	17.1	11.4	9.50	9.16	7.45	4.28	4.02	3.62	3.99	4.01	4.56
PFOS	24.4	29.6	33.0	45.9	43.4	37.3	32.3	33.5	33.9	37.8	40.1	37.9

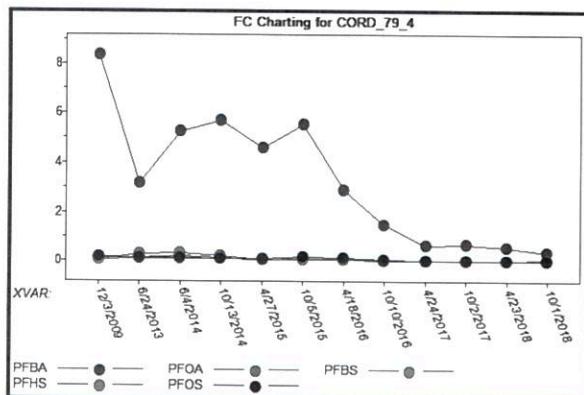
MW-3-79



MW-3-79	12/3/09	6/24/13	8/4/13	10/13/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18	10/1/18
PFBA	81.1	54.4	31.1	21.0	20.6	10.9	12.8	10.8	13.9	14.6	13.4	
PFOA	4.10	2.87	1.46	0.901	0.815	0.388	0.379	0.296	0.362	0.402	0.326	
PFBS	19.8	12.9	0.574	0.368	0.480	0.172	0.100	0.166	0.141	0.185	0.184	
PFHS	7.55	5.93	1.67	1.34	1.12	0.698	0.754	0.593	0.735	0.832	0.960	
PFOS	16.9	13.9	31.0	13.9	12.5	8.34	11.8	8.09	10.3	10.2	13.3	

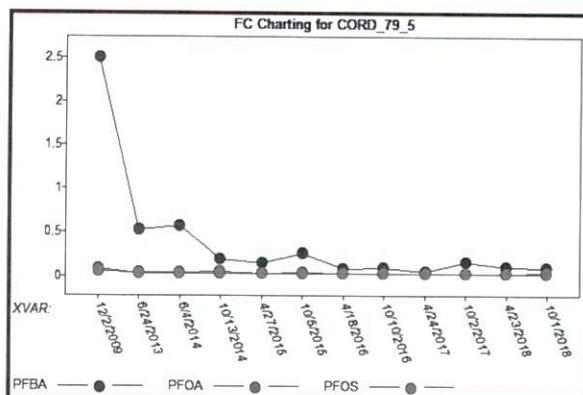
Attachment A continued: Historical Trend Chart

MW-4-79



MW-4-79	12/3/09	6/24/13	6/4/14	10/13/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18	10/1/18
PFBA	8.35	3.16	5.26	5.69	4.57	5.52	2.87	1.49	0.639	0.691	0.571	0.383
PFOA	0.123	0.154	0.219	0.127	0.0511	0.0607	0.0605	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240
PFBS	0.0533	0.0861	0.0973	0.0885	0.0711	0.105	0.0897	<0.0250	<0.0250	<0.0250	<0.0250	<0.0500
PFHS	0.0460	0.275	0.314	0.203	0.0569	0.0803	0.0615	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
PFOS	0.174	0.121	0.151	0.111	0.0807	0.169	0.145	0.0553	<0.0232	<0.0232	0.0340	0.0341

MW-5-79

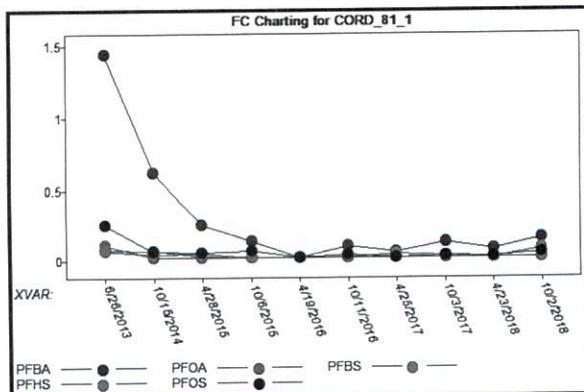


MW-5-79	12/2/09	6/24/13	6/4/14	10/13/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18	10/1/18
PFBA	<2.50	0.528	0.571	0.190	0.153	0.255	0.0845	<0.100	<0.0500	0.156	0.111	<0.100
PFOA	0.0865	0.0259	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	0.0346
PFOS	0.0548	0.0448	0.0346	0.0539	0.0246	0.0435	<0.0232	<0.0232	<0.0232	<0.0232	0.0269	0.0327

PFBS and PFHS were not detected above the reporting limit for these sampling events.

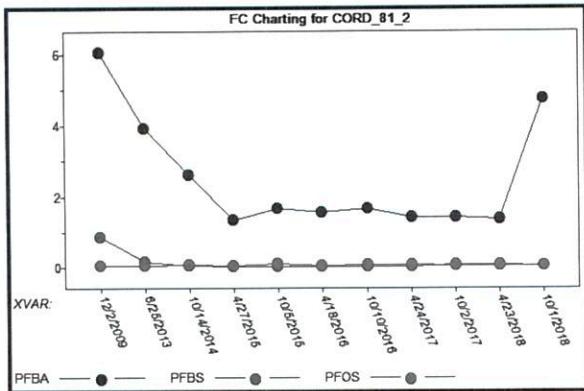
Attachment A continued: Historical Trend Chart

MW-1-81



MW-1-81	6/26/13	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/23/18	10/2/18
PFBA	1.44	0.615	0.250	0.138	<0.0250	<0.100	0.0636	0.131	0.0819	0.156
PFOA	0.108	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240
PFBS	0.0775	0.0660	0.0294	<0.0250	<0.0250	<0.0250	0.0456	0.0325	<0.0250	0.0794
PFHS	0.0706	0.0409	<0.0500	<0.0236	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
PFOS	0.247	0.0614	0.0583	0.0699	<0.0232	0.0400	<0.0232	0.0366	0.0257	0.0557

MW-2-81

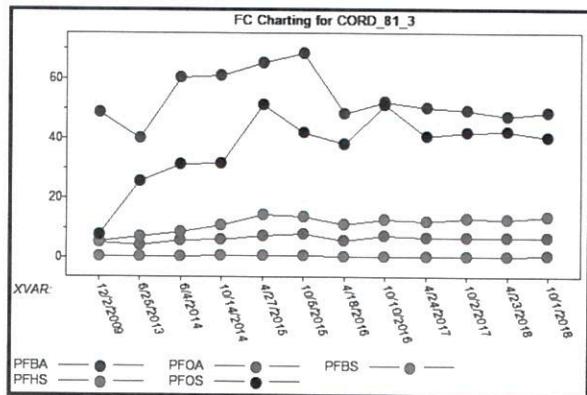


MW-2-81	12/2/09	6/25/13	10/14/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18	10/1/18
PFBA	6.04	3.92	2.60	1.34	1.66	1.57	1.67	1.43	1.44	1.38	4.74
PFBS	0.870	0.163	0.0767	0.0364	<0.0250	0.0371	<0.0250	<0.0250	0.0976	0.0886	0.0635
PFOS	0.0538	0.0609	0.103	0.0613	0.114	0.0571	0.0996	0.0867	0.0671	0.0677	0.0568

PFOA and PFHS were not detected above the reporting limit for during these sampling events.

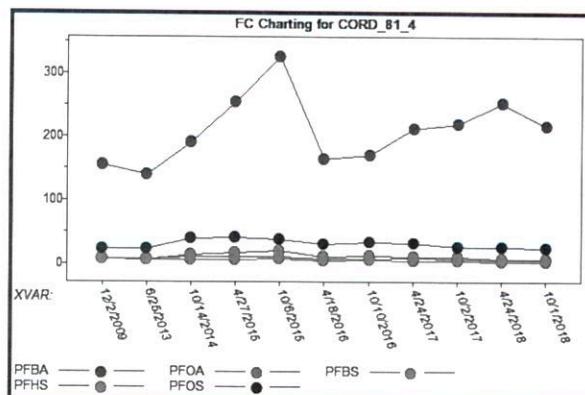
Attachment A continued: Historical Trend Chart

MW-3-81



MW-3-81	12/2/09	6/25/13	6/4/14	10/14/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18	10/1/18
PFBA	48.7	40.0	60.3	61.0	65.0	68.2	48.5	52.2	50.4	49.4	47.5	48.7
PFOA	5.19	3.98	5.84	5.97	7.22	7.85	5.75	7.26	6.56	6.62	6.63	6.79
PFBS	0.357	0.356	0.371	0.635	0.424	0.410	0.305	0.330	0.342	0.335	0.290	0.431
PFHS	5.40	6.95	8.67	10.7	14.4	13.8	11.1	12.9	12.0	13.2	12.9	13.8
PFOS	7.54	25.5	31.5	31.7	51.3	41.8	38.2	51.3	40.8	42.1	42.4	40.4

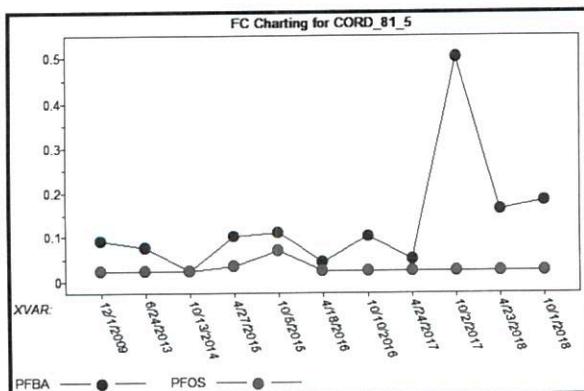
MW-4-81



MW-4-81	12/2/09	6/25/13	10/14/14	4/27/15	10/6/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18	10/1/18
PFBA	155	140	191	254	326	165	171	211	219	253	216
PFOA	6.25	5.8	6.05	5.63	6.69	4.44	4.82	4.21	3.41	2.94	2.64
PFBS	7.73	5.88	13.5	15.6	18.7	10.5	12.0	9.83	9.66	7.16	7.48
PFHS	6.99	7.49	9.86	9.96	9.89	6.99	7.67	7.80	6.65	5.92	5.80
PFOS	21.5	22.5	39.3	40.5	37.5	29.6	33.0	32.1	25.4	25.3	24.2

Attachment A continued: Historical Trend Chart

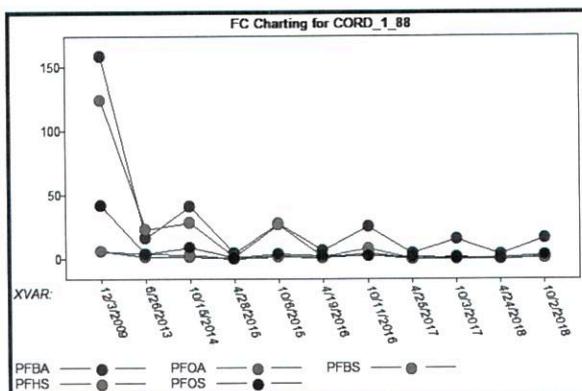
MW-5-81



MW-5-81	12/1/09	6/24/13	10/13/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18	10/1/18
PFBA	0.0891	0.0744	<0.0250	<0.100	0.108	0.0436	<0.100	<0.0500	<0.500	0.163	0.181
PFOS	<0.0253	<0.0232	<0.0232	0.0347	0.0689	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232

PFOA, PFBS and PFHS were not detected above the reporting limit for during these sampling events.

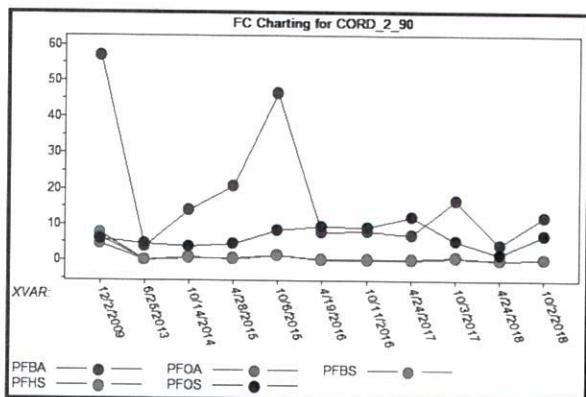
MW-1-88



MW-1-88	12/3/09	6/26/13	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18	10/2/18
PFBA	158	16.3	41.2	4.21	27.2	6.83	25.4	4.25	15.7	3.64	16.2
PFOA	5.84	1.29	1.56	0.122	1.11	0.459	2.77	0.112	0.199	<0.0240	0.416
PFBS	124	23.4	28.5	1.51	26.6	1.34	7.91	0.0982	1.64	<0.0250	1.63
PFHS	6.04	3.38	3.23	0.161	1.81	0.735	4.70	0.112	0.469	<0.0250	0.700
PFOS	41.8	3.43	9.16	0.720	3.52	1.88	2.25	1.28	0.868	0.452	2.70

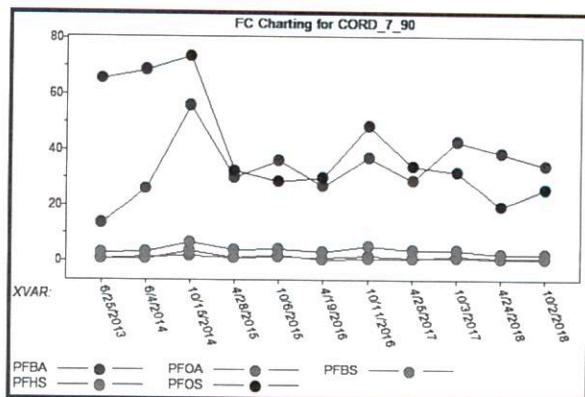
Attachment A continued: Historical Trend Chart

MW-2-90



MW-2-90	12/2/09	6/25/13	10/14/14	4/28/15	10/6/15	4/19/16	10/11/16	4/24/17	10/3/17	4/24/18	10/2/18
PFBA	56.9	3.79	13.9	20.6	46.5	7.77	8.11	7.10	16.7	4.28	12.20
PFOA	4.50	0.0770	0.772	0.306	1.38	0.154	0.103	0.154	0.746	0.0970	0.292
PFBS	7.54	0.0882	0.519	0.455	1.41	0.183	0.206	0.164	0.603	0.104	0.379
PFHS	6.50	0.0770	0.782	0.300	1.34	0.146	0.155	0.190	0.861	0.103	0.401
PFOS	5.91	4.55	3.84	4.51	8.31	9.37	9.27	12.1	5.29	1.53	7.09

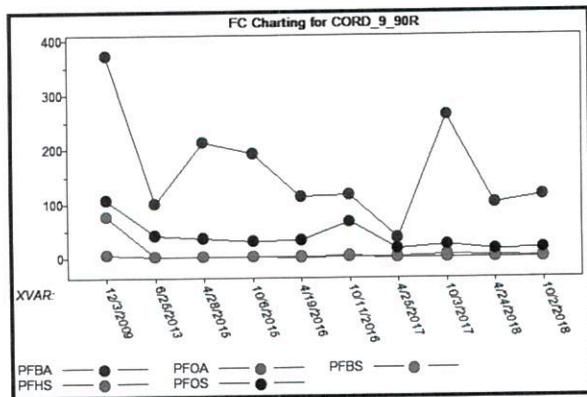
MW-7-90



MW-7-90	6/25/13	6/4/14	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18	10/2/18
PFBA	13.7	26.1	55.9	30.2	36.3	26.9	37.2	29.2	43.1	39.1	34.5
PFOA	0.946	1.35	1.90	1.07	1.43	1.08	1.72	1.19	1.08	0.841	0.741
PFBS	0.738	0.886	3.56	1.06	2.10	0.512	0.800	0.649	1.86	1.01	1.22
PFHS	2.85	3.17	6.69	4.00	4.19	3.26	5.11	3.81	3.90	2.63	2.63
PFOS	65.6	68.8	73.4	32.5	28.8	29.9	48.7	34.1	32.1	19.6	26.0

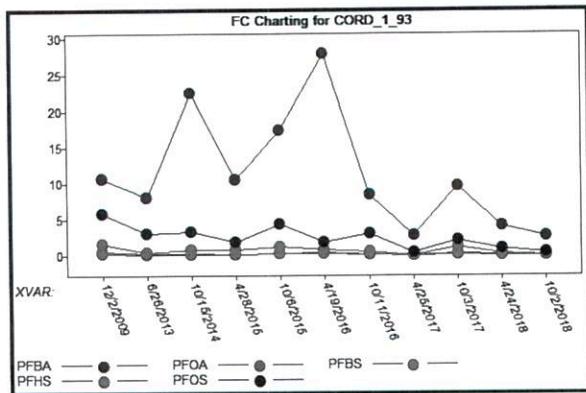
Attachment A continued: Historical Trend Chart

MW-9-90R



MW-9-90R	12/3/09	6/25/13	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18	10/2/18
PFBA	372	99.8	213	192	112	116	35.0	261	101	114
PFOA	6.09	1.86	2.11	1.82	1.19	2.43	0.480	0.787	0.475	0.931
PFBS	76.1	1.84	2.43	2.32	1.02	1.76	1.39	5.42	4.01	2.05
PFHS	4.82	2.43	2.02	2.01	1.53	2.86	0.724	1.06	0.765	0.775
PFOS	107	40.2	34.5	30.5	31.6	64.8	16.8	23.2	14.2	15.4

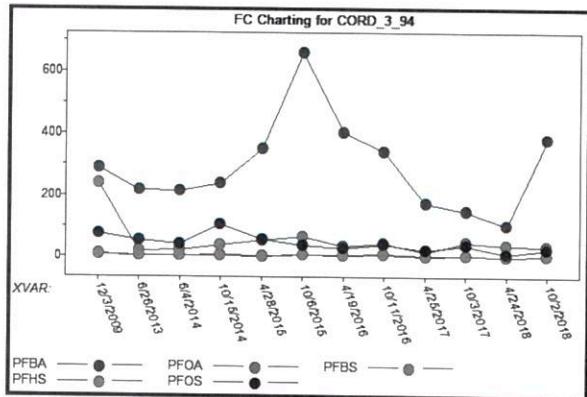
MW-1-93



MW-1-93	12/2/09	6/26/13	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18	10/2/18
PFBA	10.7	8.05	22.5	10.5	17.4	27.9	8.40	2.74	9.68	4.08	2.61
PFOA	0.497	0.269	0.180	0.150	0.208	0.323	0.148	0.0442	0.174	0.0520	0.0256
PFBS	0.217	0.117	0.259	0.127	0.202	0.37	0.0910	0.0468	0.266	0.0936	0.0590
PFHS	1.60	0.420	0.841	0.804	1.15	0.753	0.479	0.0515	1.14	0.270	0.0599
PFOS	5.75	3.03	3.31	1.84	4.41	1.82	2.99	0.377	2.16	0.937	0.340

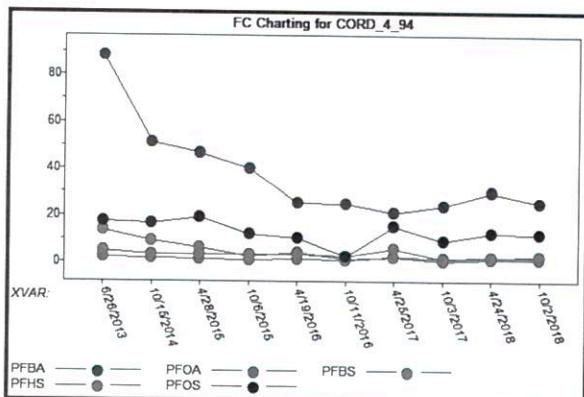
Attachment A continued: Historical Trend Chart

MW-3-94



MW-3-94	12/3/09	6/26/13	6/4/14	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18	10/2/18
PFBA	290	217	213	239	350	658	403	342	174	148	104	381
PFOA	6.66	3.19	2.42	5.00	3.45	5.75	5.12	9.53	4.80	3.19	0.899	2.24
PFBS	238	17.4	20.8	38.9	52.3	64.5	33.1	43.7	15.4	46.1	38.3	33.2
PFHS	8.97	3.21	1.97	3.75	1.52	5.45	3.59	6.21	1.49	2.73	0.765	3.25
PFOS	76.2	52.7	41.7	107	57.1	38.4	29.2	41.9	20.5	36.8	10.2	24.4

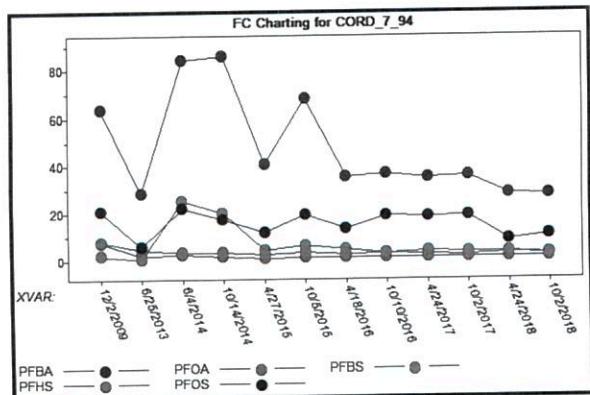
MW-4-94



MW-4-94	6/26/13	10/15/14	4/28/15	10/6/15	4/19/16	10/11/16	4/25/17	10/3/17	4/24/18	10/2/18
PFBA	88.3	51.0	46.4	40.0	25.3	24.9	21.4	24.1	29.8	25.3
PFOA	2.29	1.83	1.46	1.11	1.50	1.03	2.39	0.661	1.24	1.37
PFBS	14.0	9.48	6.52	2.81	4.15	1.48	2.41	1.72	2.19	2.40
PFHS	5.06	3.41	3.41	3.32	3.58	2.83	5.79	1.25	2.29	2.64
PFOS	17.7	16.8	19.1	12.2	10.4	2.57	15.7	9.23	12.7	12.3

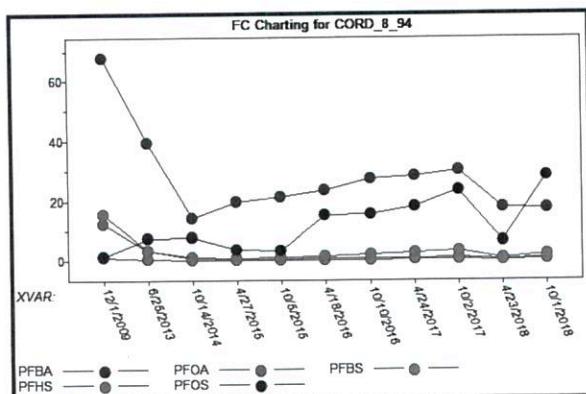
Attachment A continued: Historical Trend Chart

MW-7-94



MW-7-94	12/2/09	6/25/13	6/4/14	10/14/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/24/18	10/2/18
PFBA	63.4	28.3	84.2	85.7	40.5	67.9	35.3	36.4	35.0	35.7	28.1	27.5
PFOA	7.23	2.04	2.46	1.50	0.719	1.21	1.03	1.04	1.03	0.910	0.967	0.902
PFBS	1.90	0.311	25.2	20.0	3.74	6.07	4.16	2.52	2.23	1.98	2.86	2.10
PFHS	7.68	4.45	3.07	2.88	2.39	3.21	2.44	2.82	3.30	3.25	3.22	2.40
PFOS	20.8	5.44	22.1	17.3	11.7	19.3	13.2	18.8	18.3	18.7	8.43	10.5

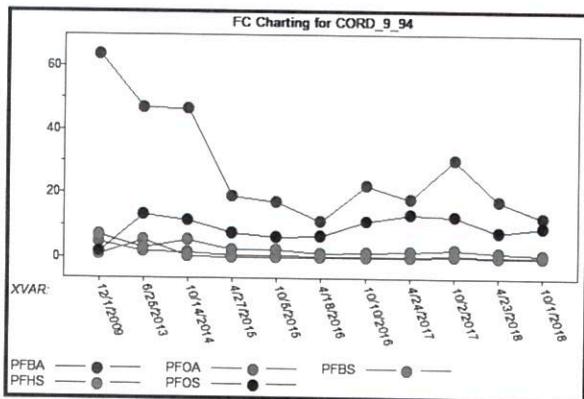
MW-8-94



MW-8-94	12/1/09	6/25/13	10/14/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18	10/1/18
PFBA	67.6	39.3	14.1	19.5	21.0	23.4	27.3	28.1	30.2	17.7	17.3
PFOA	12.2	3.23	0.647	0.402	0.408	0.634	0.806	0.734	1.16	0.324	0.745
PFBS	1.04	0.480	0.162	0.178	0.175	0.207	0.205	0.269	0.269	0.263	0.269
PFHS	15.3	3.15	1.08	0.847	0.919	1.41	1.93	2.54	3.38	0.850	1.99
PFOS	1.27	7.30	7.81	3.72	3.34	15.2	15.5	18.0	23.4	6.33	28.3

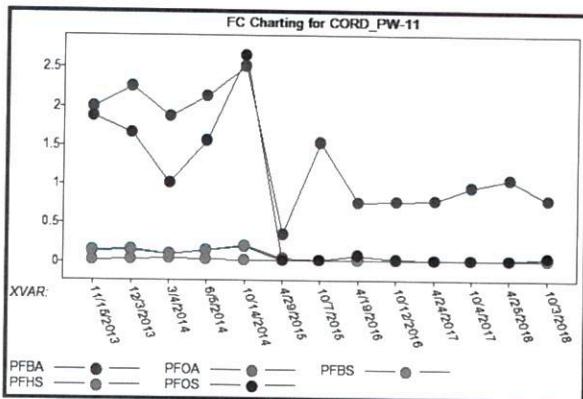
Attachment A continued: Historical Trend Chart

MW-9-94



MW-9-94	12/1/09	6/25/13	10/14/14	4/27/15	10/5/15	4/18/16	10/10/16	4/24/17	10/2/17	4/23/18	10/1/18
PFBA	63.5	46.8	46.4	18.9	17.2	11.2	22.2	18.1	30.2	17.4	12.3
PFOA	4.79	1.88	1.62	0.786	0.767	0.371	0.368	0.352	0.613	0.473	0.244
PFBS	0.894	5.41	0.398	0.151	0.138	0.0993	0.155	0.148	0.250	0.158	0.158
PFHS	6.91	2.99	5.32	2.53	2.32	1.28	1.51	1.74	2.56	1.49	0.920
PFOS	1.93	13.1	11.4	7.39	6.20	6.49	11.0	13.1	12.6	7.98	9.23

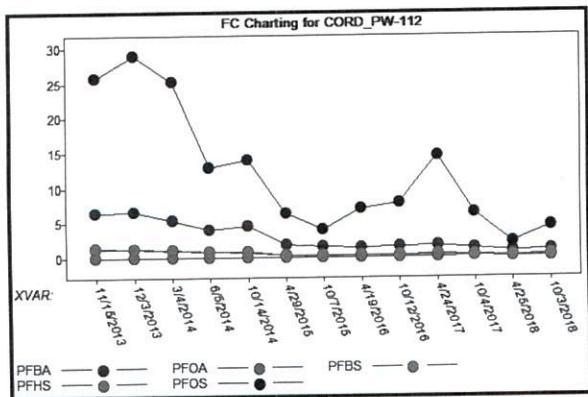
PW11



PW11	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18	10/3/18
PFBA	2.00	2.26	1.87	2.13	2.51	0.357	1.53	0.766	0.772	0.791	0.963	1.06	0.805
PFOA	0.139	0.146	0.0899	0.144	0.199	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240
PFBS	<0.0250	0.0293	<0.0500	0.0386	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0500
PFHS	0.144	0.159	0.0976	0.140	0.213	<0.0500	<0.0236	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
PFOS	1.87	1.66	1.01	1.56	2.65	<0.0232	0.0247	0.0845	0.0379	<0.0232	0.0260	<0.0232	0.0557

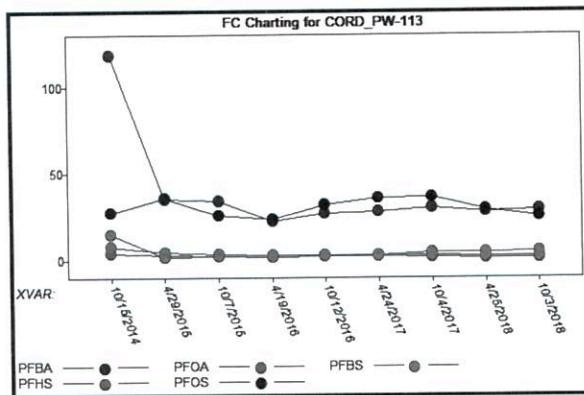
Attachment A continued: Historical Trend Chart

PW112



PW-112	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18	10/3/18
PFBA	6.43	6.51	5.30	3.92	4.49	1.83	1.52	1.39	1.47	1.69	1.28	0.805	0.926
PFOA	1.19	1.21	0.960	0.778	0.725	0.215	0.191	0.225	0.201	0.261	0.199	0.0920	0.110
PFBS	0.0509	0.0662	<0.0500	0.0408	0.0421	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.100	<0.0250	<0.0500
PFHS	1.33	1.29	1.06	0.785	0.810	0.256	0.280	0.330	0.317	0.434	0.324	0.153	0.210
PFOS	25.8	28.9	25.3	12.8	13.9	6.29	3.95	6.97	7.82	14.4	6.33	2.07	4.37

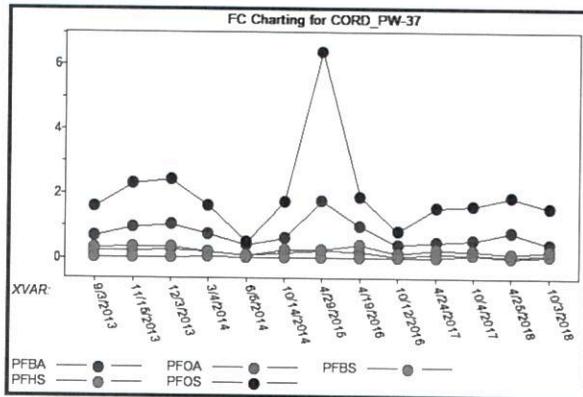
PW113



PW-113	10/15/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18	10/3/18
PFBA	118	35.4	34.5	22.6	27.0	28.3	30.6	28.4	29.1
PFOA	4.05	2.99	2.39	1.86	2.08	2.21	1.81	1.39	1.25
PFBS	14.8	1.67	2.35	1.87	2.42	3.03	4.49	4.42	5.25
PFHS	7.64	4.58	3.57	2.66	2.89	3.05	2.65	2.06	2.02
PFOS	27.8	35.8	26.1	23.6	32.2	35.8	36.4	29.1	25.2

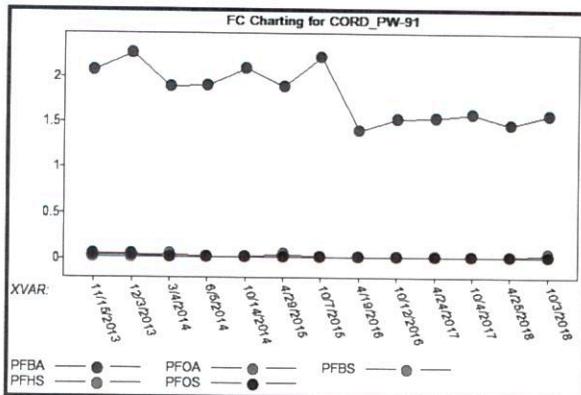
Attachment A continued: Historical Trend Chart

PW37



PW-37	9/3/13	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18	10/3/18
PFBA	0.691	0.949	1.05	0.749	0.418	0.623	1.78	0.977	0.422	0.489	0.561	0.788	0.452
PFOA	0.219	0.243	0.264	0.193	0.0657	0.177	0.219	0.188	0.0624	0.139	0.115	0.0865	0.115
PFBS	<0.0250	<0.0250	0.0307	<0.0500	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.100	<0.0250	0.0674
PFHS	0.308	0.35	0.361	0.209	0.0715	0.258	0.262	0.418	0.133	0.266	0.221	0.146	0.216
PFOS	1.60	2.31	2.42	1.62	0.506	1.73	6.40	1.88	0.822	1.55	1.63	1.88	1.57

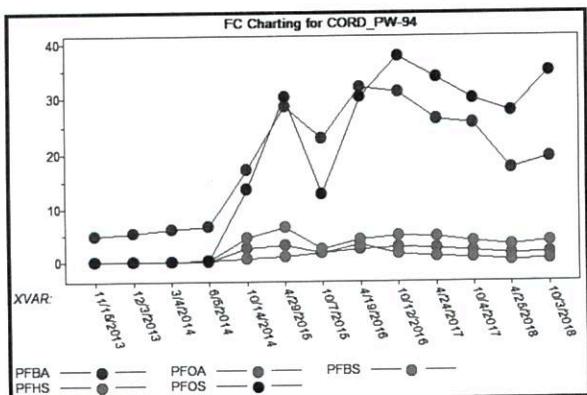
PW91



PW-91	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18	10/3/18
PFBA	2.07	2.26	1.89	1.90	2.09	1.89	2.22	1.41	1.53	1.54	1.59	1.47	1.57
PFOA	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240	<0.0240
PFBS	<0.0250	<0.0250	<0.0500	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	0.0580
PFHS	<0.0500	<0.0500	<0.0250	<0.0250	<0.0250	<0.0500	<0.0236	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250	<0.0250
PFOS	<0.0464	<0.0464	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232	<0.0232

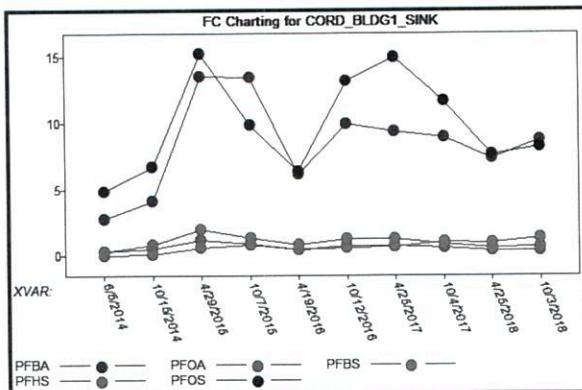
Attachment A continued: Historical Trend Chart

PW94



PW-94	11/15/13	12/3/13	3/4/14	6/5/14	10/14/14	4/29/15	10/7/15	4/19/16	10/12/16	4/24/17	10/4/17	4/25/18	10/3/18
PFBA	4.86	5.39	6.07	6.53	17.0	28.4	22.7	32.0	31.2	26.2	25.5	17.3	19.3
PFOA	<0.0240	<0.0240	<0.0240	0.0682	2.48	3.06	1.59	2.33	2.73	2.47	2.03	1.50	1.68
PFBS	0.0569	0.0727	0.0703	0.0978	0.470	0.798	1.54	3.24	1.46	0.848	0.740	0.251	0.299
PFHS	<0.0500	<0.0500	<0.0250	0.0859	4.38	6.36	2.39	4.16	4.80	4.55	3.79	2.96	3.65
PFOS	<0.0464	<0.0464	<0.0232	0.238	13.5	30.3	12.6	30.2	37.7	33.8	29.9	27.5	34.8

Building 1 Coffee Sink



Bldg 1 Coffee Sink	6/5/14	10/15/14	4/29/15	10/7/15	4/19/16	10/12/16	4/25/17	10/4/17	4/25/18	10/3/18
PFBA	2.71	4.13	13.5	13.4	6.14	9.94	9.33	8.90	7.36	8.66
PFOA	0.320	0.541	1.19	0.886	0.445	0.770	0.771	0.563	0.379	0.385
PFBS	0.0325	0.0665	0.621	0.801	0.474	0.626	0.693	1.05	0.953	1.32
PFHS	0.312	0.781	1.99	1.30	0.787	1.24	1.22	0.873	0.597	0.674
PFOS	4.81	6.66	15.2	9.81	6.35	13.1	14.9	11.6	7.60	8.18

3M EHS LABORATORY
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St. Paul, MN 55144

Phone: (651) 733-9873
Alt. Phone: (651) 736-6559
Fax: (651) 733-4687

Project: ISO18-16-02

Requester: Blomquist, Karie Lyn (MAPLEWOOL)
Department: 108100 Site Source: 01L1M100
Project Number:
Date Created: 9/25/2018
Project Description: Cordova PFC Groundwater Monitoring
Copy List: Sheller, Patricia M (CORDOVA-3MUS-IL)
Comments:

Completion Date:
Project Lead: Susan T. Wolf
Phone Number: 651-733-9851
Email Address: stwolf@mmm.com

<u>3M Sample Number</u>	<u>Sample Description</u>	<u>Date/Time Sampled</u>	<u>Matrix</u>	<u>Comment</u>
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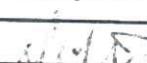
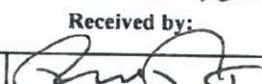
ISO18-16-02-001	COIL-GW-MW-1-79-0- 181003	10/3/18 08:15	WG	
ISO18-16-02-001-DUP	COIL-GW-MW-1-79-DB- 181003	1 1	WG	
ISO18-16-02-002	COIL-GW-MW-3-79-0- 181001	10/1/18 12:30	WG	
ISO18-16-02-002-DUP	COIL-GW-MW-3-79-DB- 181001	1 1	WG	
ISO18-16-02-003	COIL-GW-MW-4-79-0- 181001	10/1/18 11:35	WG	
ISO18-16-02-003-DUP	COIL-GW-MW-4-79-DB- 181001	1 1	WG	
ISO18-16-02-003-FMS	COIL-GW-MW-4-79-FMS- 181001	1 1	WQ	
ISO18-16-02-004	COIL-GW-MW-5-79-0- 181001	10/1/18 10:40	WG	
ISO18-16-02-004-DUP	COIL-GW-MW-5-79-DB- 181001	1 1	WG	
ISO18-16-02-005	COIL-GW-MW-1-81-0- 181002	10/2/18 10:05	WG	
ISO18-16-02-005-DUP	COIL-GW-MW-1-81-0-DB- 181002	1 1	WG	
ISO18-16-02-006	COIL-GW-MW-3-81-0- 181001	10/1/18 14:30	WG	
ISO18-16-02-006-DUP	COIL-GW-MW-3-81-0-DB- 181001	1 1	WG	
ISO18-16-02-007	COIL-GW-MW-1-88-0- 181002	10/2/18 10:40	WG	

Sample Condition Upon Receipt: Acceptable All items accounted for

Temperature: 4 Deg C Received on Ice Other:

Collected by (print): DAVE CAIRNS

Collector's signature: 

Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time
		10/4/18	11:30			10/4/18	11:30 AM

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Alt. Phone: (651) 736-6559
Fax: (651) 733-4687

Project: ISO18-16-02 (cont.)

Requester: Blomquist, Karie Lyn (MAPLEWOOL)
Department: 108100 Site Source: 01L1M100
Project Number:
Date Created: 9/25/2018

Project Description: Cordova PFC Groundwater Monitoring

Completion Date:
Project Lead: Susan T. Wolf
Phone Number: 651-733-9851
Email Address: stwolf@mmm.com

<u>3M Sample Number</u>	<u>Sample Description</u>	<u>Date/Time Sampled</u>	<u>Matrix</u>	<u>Comment</u>
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ISO18-16-02-007-DUP	COIL-GW-MW-1-88-DB- 181002	10/2/18 1040	WG	
ISO18-16-02-007-FMS	COIL-GW-MW-1-88-FMS- 181002	↓ ↓	WQ	
ISO18-16-02-008	COIL-GW-MW-2-90-0- 181002	10/2/18 0855	WG	
ISO18-16-02-008-DUP	COIL-GW-MW-2-90-DB- 181002	↓ ↓	WG	
ISO18-16-02-009	COIL-GW-MW-7-90-0- 181002	10/2/18 1135	WG	
ISO18-16-02-009-DUP	COIL-GW-MW-7-90-DB- 181002	↓ ↓	WG	
ISO18-16-02-010	COIL-GW-MW-9-90R-0- 181002	10/2/18 1320	WG	
ISO18-16-02-010-DUP	COIL-GW-MW-9-90R-DB- 181002	↓ ↓	WG	
ISO18-16-02-011	COIL-GW-MW-1-93-0- 181002	10/2/18 1105	WG	
ISO18-16-02-011-DUP	COIL-GW-MW-1-93-DB- 181002	↓ ↓	WG	
ISO18-16-02-012	COIL-GW-MW-3-94-0- 181002	10/2/18 1245	WG	
ISO18-16-02-012-DUP	COIL-GW-MW-3-94-DB- 181002	↓ ↓	WG	
ISO18-16-02-013	COIL-GW-MW-4-94-0- 181002	10/2/18 1205	WG	
ISO18-16-02-013-DUP	COIL-GW-MW-4-94-DB- 181002	↓ ↓	WG	
ISO18-16-02-014	COIL-GW-MW-7-94-0- 181002	10/2/18 0805	WG	
ISO18-16-02-014-DUP	COIL-GW-MW-7-94-DB- 181002	↓ ↓	WG	
ISO18-16-02-014-FMS	COIL-GW-MW-7-94-FMS- 181002	↓ ↓	WQ	

Sample Condition Upon Receipt: Acceptable All items accounted forTemperature: 4 Deg C Received on Ice Other:

Collected by (print): DAVE CAIRNS

Collector's signature: 

Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time
	DAVE CAIRNS	10/4/18	11:30		Susan Wolf	10/4/18	11:30 AM

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St. Paul, MN 55144

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Fax: (651) 733-4687

Project: ISO18-16-02 (cont.)

Requester: Blomquist, Karie Lyn (MAPLEWOOL)
Department: 108100 Site Source: 01L1M100
Project Number:
Date Created: 9/25/2018
Project Description: Cordova PFC Groundwater Monitoring

Completion Date:
Project Lead: Susan T. Wolf
Phone Number: 651-733-9851
Email Address: stwolf@mmm.com

<u>3M Sample Number</u>	<u>Sample Description</u>	<u>Date/Time Sampled</u>	<u>Matrix</u>	<u>Comment</u>
ISO18-16-02-015	COIL-GW-MW-8-94-0- 1B1001	10/1/18 1615	WG	
ISO18-16-02-015-DUP	COIL-GW-MW-8-94-DB- 1B1001	↓ ↓	WG	
ISO18-16-02-016	COIL-GW-MW-9-94-0- 1B1001	10/1/18 1545	WG	
ISO18-16-02-016-DUP	COIL-GW-MW-9-94-DB- 1B1001	↓ ↓	WG	
ISO18-16-02-017	COIL-GW-MW-2-81-0- 1B1001	10/1/18 1345	WG	
ISO18-16-02-017-DUP	COIL-GW-MW-2-81-DB- 1B1001	↓ ↓	WG	
ISO18-16-02-018	COIL-GW-MW-4-81-0- 1B1001	10/1/18 1520	WG	
ISO18-16-02-018-DUP	COIL-GW-MW-4-81-DB- 1B1001	↓ ↓	WG	
ISO18-16-02-018-FMS	COIL-GW-MW-4-81-FMS- 1B1001	↓ ↓	WQ	
ISO18-16-02-019	COIL-GW-MW-5-81-0- 1B1001	10/1/18 0930	WG	
ISO18-16-02-019-DUP	COIL-GW-MW-5-81-DB- 1B1001	↓ ↓	WG	
ISO18-16-02-020	COIL-GW-PW-11-0- 1B1003	10/3/18 0850	WG	
ISO18-16-02-020-DUP	COIL-GW-PW-11-DB- 1B1003	↓ ↓	WG	
ISO18-16-02-021	COIL-GW-PW-112-0- 1B1003	10/3/18 09:00	WG	
ISO18-16-02-021-DUP	COIL-GW-PW-112-DB- 1B1003	↓ ↓	WG	
ISO18-16-02-022	COIL-GW-PW-113-0- 1B1003	10/3/18 09:15	WG	
ISO18-16-02-022-DUP	COIL-GW-PW-113-DB- 1B1003	↓ ↓	WG	

Sample Condition Upon Receipt: Acceptable All items accounted for

Temperature: 4 Deg C Received on Ice Other:

Collected by (print): DAVE CAIRNS Collector's signature: mlw

Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time
	<u>mlw</u>	10/4/18	11:30		<u>SLR</u>	10/4/18	11:30 AM

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St. Paul, MN 55144

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Alt. Phone: (651) 736-6559
Fax: (651) 733-4687

Project: ISO18-16-02 (cont.)

Requester: Blomquist, Karie Lyn (MAPLEWOOL)
Department: 108100 Site Source: 01L1M100
Project Number:
Date Created: 9/25/2018

Project Description: Cordova PFC Groundwater Monitoring

Completion Date:
Project Lead: Susan T. Wolf
Phone Number: 651-733-9851
Email Address: stwolf@mmm.com

3M Sample Number	Sample Description	Date/Time Sampled	Matrix	Comment
ISO18-16-02-022-FMS	COIL-GW-PW-113-FMS- 181003	10/3/18 09:15	WQ	
ISO18-16-02-023	COIL-GW-PW-37-0- 181003	10/3/18 09:05	WG	
ISO18-16-02-023-DUP	COIL-GW-PW-37-DB- 181003	↓ ↓	WG	
ISO18-16-02-024	COIL-GW-PW-91-0- 181003	10/3/18 08:40	WG	
ISO18-16-02-024-DUP	COIL-GW-PW-91-DB- 181003	↓ ↓	WG	
ISO18-16-02-025	COIL-GW-PW-94-0- 181003	10/3/18 08:30	WG	
ISO18-16-02-025-DUP	COIL-GW-PW-94-DB- 181003	↓ ↓	WG	
ISO18-16-02-025-FMS	COIL-GW-PW-94-FMS- 181003	↓ ↓	WQ	
ISO18-16-02-026	COIL-GW-Bldg 1 Coffee Sink-0- 181003	10/3/18 12:30	WG	SLIGHT OVERFILL
ISO18-16-02-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB- 181003	↓ ↓	WG	
ISO18-16-02-027	COIL-GW-23321-0- — COULD NOT SAMPLE —	—	WG	COULD NOT SAMPLE
ISO18-16-02-027-DUP	COIL-GW-23321-DB- — COULD NOT SAMPLE —	—	WG	COULD NOT SAMPLE
ISO18-16-02-028	COIL-GW-22610-0- 181002	10/2/18 16:35	WG	
ISO18-16-02-028-DUP	COIL-GW-22610-DB- 181002	↓ ↓	WG	
ISO18-16-02-029	COIL-GW-22704-0- 181002	10/2/18 16:50	WG	
ISO18-16-02-029-DUP	COIL-GW-22704-DB- 181002	↓ ↓	WG	
ISO18-16-02-029-FMS	COIL-GW-22704-FMS- 181002	↓ ↓	WQ	

3M Sample Number	Sample Description	Date/Time Sampled	Matrix	Comment
ISO18-16-02-022-FMS	COIL-GW-PW-113-FMS- 181003	10/3/18 09:15	WQ	
ISO18-16-02-023	COIL-GW-PW-37-0- 181003	10/3/18 09:05	WG	
ISO18-16-02-023-DUP	COIL-GW-PW-37-DB- 181003	↓ ↓	WG	
ISO18-16-02-024	COIL-GW-PW-91-0- 181003	10/3/18 08:40	WG	
ISO18-16-02-024-DUP	COIL-GW-PW-91-DB- 181003	↓ ↓	WG	
ISO18-16-02-025	COIL-GW-PW-94-0- 181003	10/3/18 08:30	WG	
ISO18-16-02-025-DUP	COIL-GW-PW-94-DB- 181003	↓ ↓	WG	
ISO18-16-02-025-FMS	COIL-GW-PW-94-FMS- 181003	↓ ↓	WQ	
ISO18-16-02-026	COIL-GW-Bldg 1 Coffee Sink-0- 181003	10/3/18 12:30	WG	SLIGHT OVERFILL
ISO18-16-02-026-DUP	COIL-GW-Bldg 1 Coffee Sink-DB- 181003	↓ ↓	WG	
ISO18-16-02-027	COIL-GW-23321-0- — COULD NOT SAMPLE —	—	WG	COULD NOT SAMPLE
ISO18-16-02-027-DUP	COIL-GW-23321-DB- — COULD NOT SAMPLE —	—	WG	COULD NOT SAMPLE
ISO18-16-02-028	COIL-GW-22610-0- 181002	10/2/18 16:35	WG	
ISO18-16-02-028-DUP	COIL-GW-22610-DB- 181002	↓ ↓	WG	
ISO18-16-02-029	COIL-GW-22704-0- 181002	10/2/18 16:50	WG	
ISO18-16-02-029-DUP	COIL-GW-22704-DB- 181002	↓ ↓	WG	
ISO18-16-02-029-FMS	COIL-GW-22704-FMS- 181002	↓ ↓	WQ	

Sample Condition Upon Receipt: Acceptable All items accounted forTemperature: 4 Deg C Received on Ice Other:Collected by (print): DAVE CAIRNS Collector's signature: mlm

Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time
	<u>mlm</u>	10/4/18	11:30		<u>Susan S</u>	10/4/18	11:30AM

Attachment B: Chain of Custody Form

3M EHS LABORATORY
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 St. Paul, MN 55144

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 Fax: (651) 733-4687

Project: ISO18-16-02 (cont.)

Requester: Blomquist, Karie Lyn (MAPLEWOOL)
 Department: 108100 Site Source: 01L1M100
 Project Number:
 Date Created: 9/25/2018
 Project Description: Cordova PFC Groundwater Monitoring

Completion Date:
 Project Lead: Susan T. Wolf
 Phone Number: 651-733-9851
 Email Address: stwolf@mmm.com

<u>3M Sample Number</u>	<u>Sample Description</u>	<u>Date/Time Sampled</u>	<u>Matrix</u>	<u>Comment</u>
ISO18-16-02-030	COIL-GW-22703-0- 181002	10/2/18	17:00	WG
ISO18-16-02-030-DUP	COIL-GW-22703-DB- 181002	↓	↓	WG
ISO18-16-02-031	COIL-GW-22414-0- 181002	10/2/18	17:10	WG
ISO18-16-02-031-DUP	COIL-GW-22414-DB- 181002	↓	↓	WG
ISO18-16-02-032	COIL-GW-22009-0- 181002	10/2/18	17:25	WG
ISO18-16-02-032-DUP	COIL-GW-22009-DB- 181002	↓	↓	WG
ISO18-16-02-033	COIL-GW-21421-0- 181002	10/2/18	16:15	WG
ISO18-16-02-033-DUP	COIL-GW-21421-DB- 181002	↓	↓	WG
ISO18-16-02-033-FMS	COIL-GW-21421-FMS- 181002	↓	↓	WQ
ISO18-16-02-034	COIL-GW-TRIP-0- 180927	9/27/18	11:45 am	WQ
ISO18-16-02-034-FMS	COIL-GW-TRIP-FMS- 180927	9/27/18	11:45 am	WQ
ISO18-16-02-035	COIL-GW-RB01-MW-5-74-0- 181001	10/1/18	0945	WQ
ISO18-16-02-036	COIL-GW -RB02-MW-3-94-0- 181002	10/2/18	1220	WQ

ISO18-16-02-030	COIL-GW-22703-0- 181002	10/2/18	17:00	WG	
ISO18-16-02-030-DUP	COIL-GW-22703-DB- 181002	↓	↓	WG	
ISO18-16-02-031	COIL-GW-22414-0- 181002	10/2/18	17:10	WG	
ISO18-16-02-031-DUP	COIL-GW-22414-DB- 181002	↓	↓	WG	
ISO18-16-02-032	COIL-GW-22009-0- 181002	10/2/18	17:25	WG	
ISO18-16-02-032-DUP	COIL-GW-22009-DB- 181002	↓	↓	WG	
ISO18-16-02-033	COIL-GW-21421-0- 181002	10/2/18	16:15	WG	
ISO18-16-02-033-DUP	COIL-GW-21421-DB- 181002	↓	↓	WG	
ISO18-16-02-033-FMS	COIL-GW-21421-FMS- 181002	↓	↓	WQ	
ISO18-16-02-034	COIL-GW-TRIP-0- 180927	9/27/18	11:45 am	WQ	
ISO18-16-02-034-FMS	COIL-GW-TRIP-FMS- 180927	9/27/18	11:45 am	WQ	
ISO18-16-02-035	COIL-GW-RB01-MW-5-74-0- 181001	10/1/18	0945	WQ	
ISO18-16-02-036	COIL-GW -RB02-MW-3-94-0- 181002	10/2/18	1220	WQ	

Sample Condition Upon Receipt: Acceptable All items accounted forTemperature: 4 Deg C Received on Ice Other:Collected by (print): DAVE CAIRNS Collector's signature: DAVE

Item #	Relinquished by:	Date	Time	Shipped Via	Received by:	Date	Time

<u>DAVE</u>	<u>10/4/18</u>	<u>11:50</u>		<u>DAVE</u>	<u>10/4/18</u>	<u>16:30</u>

